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Plastics

DEALING WITH THE MANUFACTURE USES AND POTENTIALITIES OF PLASTIC MATERIALS

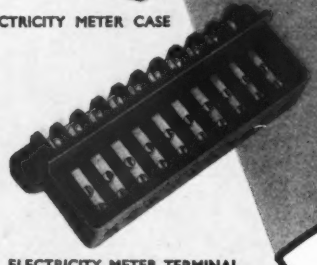
MOULDINGS *for every* MODERN PURPOSE

MOULDED TELEPHONE PARTS

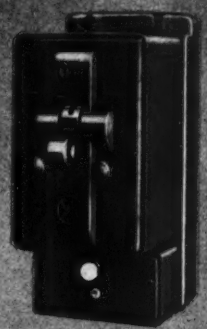
"ELO" LAVATORY SEAT

ELECTRIC DRILL CASE

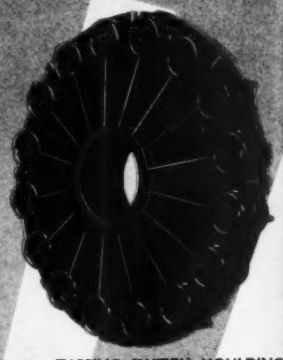
ELECTRICITY METER CASE



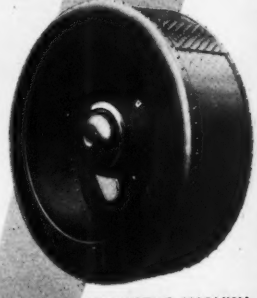
ELECTRICITY METER TERMINAL



CIRCUIT BREAKER MOULDING



TAPPING SWITCH MOULDING



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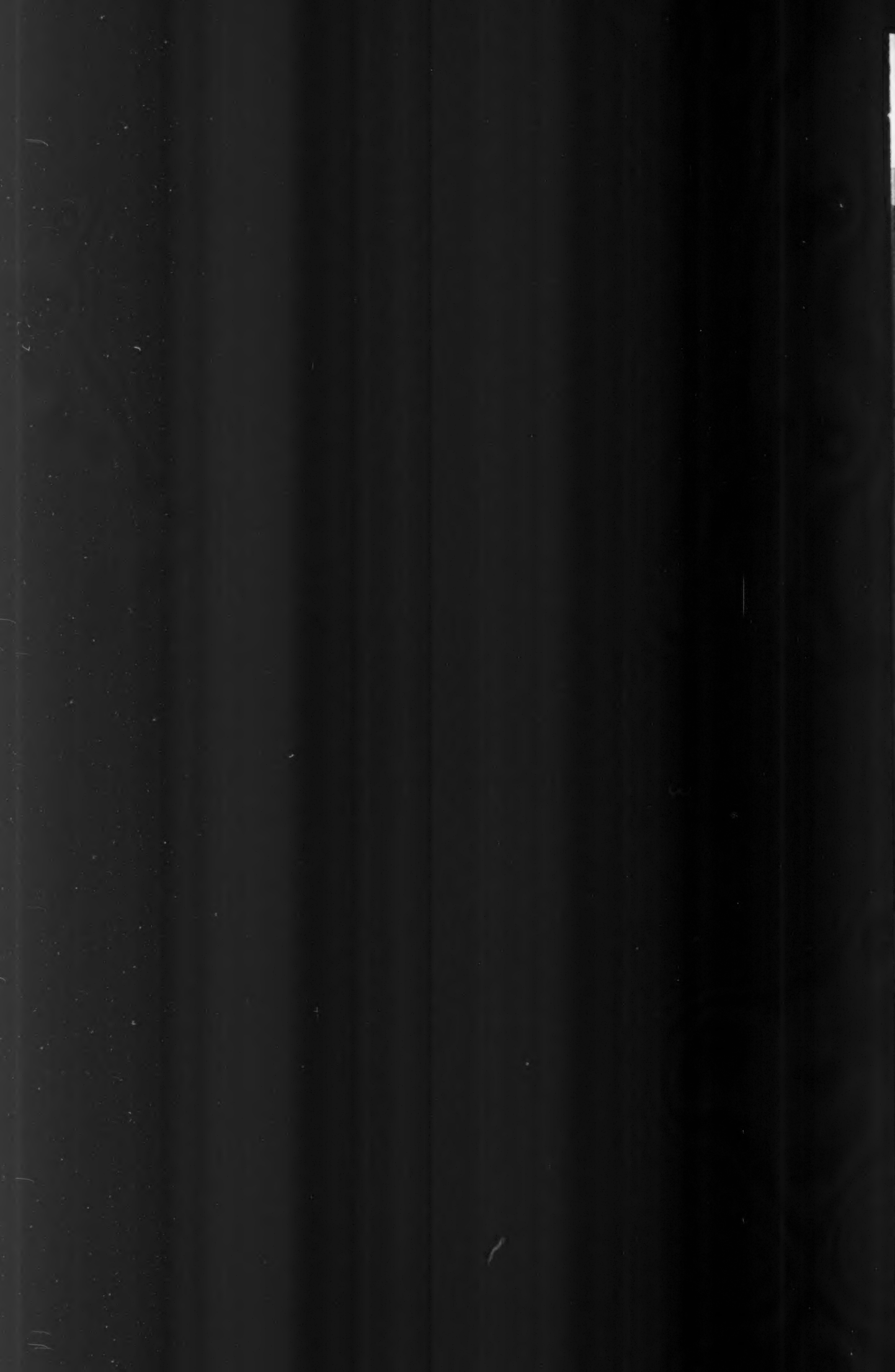

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Vol. IV MARCH, 1940 No. 34

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"PLASTICS" is published in London, England, at the beginning of each month.

Head Offices: Bowling Green Lane, London, E.C.1.

Inland Telegrams: "*Pressimus, Smith, London.*"
Cables - - "*Pressimus, London.*"
Telephone - *Terminus 3636 (Private Exchange).*

Midland Office — 50, Hertford Street, Coventry.
Telephone—Coventry 60095 (2 lines).
Telegrams—"*Presswork, Coventry.*"

Northern Offices—Manchester: Deansgate House, 274, Deansgate.
Telephone—Blackfriars 5038-9.
Telegrams—"*Presswork, Manchester.*"

SUBSCRIPTION—"PLASTICS" will be mailed regularly to any address in the United Kingdom or abroad for—
Twelve issues for 15s. post free; Canada and Newfoundland 12 for 13s. 6d.; pro rata for fewer numbers.

COMMUNICATIONS—All letters regarding subscriptions, advertisements and other business matters must be addressed to The Manager, Bowling Green Lane, London, E.C.1.

TEMPLE PRESS LIMITED
Proprietors, Printers and Publishers of "The Motor," "The Light Car," "The Commercial Motor," "Motor Cycling," "Cycling," "The Motor Ship," "The Motor Boat and Yachting," "The Oil Engine," "The Aeroplane" and "Light Metals."
Bowling Green Lane, London, E.C.1.

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A Material has been provided . . .

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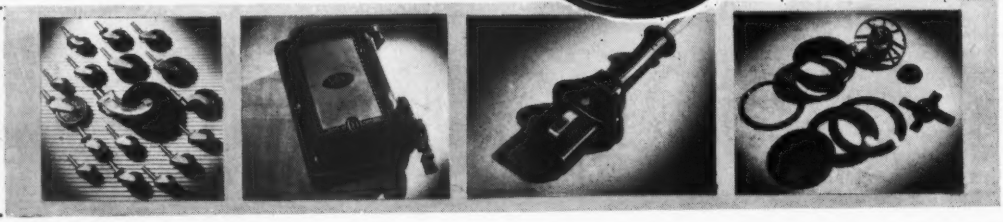
The illustrations alongside show some typical illustrations of the many varied applications of BAKELITE Moulding Materials.



THE MATERIAL OF INFINITE USES

Vol. IV. No. 34 MARCH, 1940

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.I.C.
Offices - Bowling Green Lane, London, E.C.1

ERSATZ

ELSEWHERE in this issue we publish, at the request of a reader, an admittedly incomplete survey of some of the materials Germany is manufacturing, generally from native substances, to replace some of those which she normally imported in peace times. It is a fascinating subject, economically and scientifically, and while we know, and the Germans know, too, that some of the substitutes cannot hold economic water to-day, they may have a profound effect on our industrial life to-morrow.

Coal, lime, salt, air, wood, petroleum, rubber, sulphur, mica, asbestos, cotton, iron, copper, tin, lead, mercury, nickel, aluminium, magnesium, zinc, chromium, vanadium and vegetable oils and fats, these are among the most important of raw materials, non-metals and metals, that a modern nation must have before she can undertake a long war or possess the ability to avoid using them to replace them with other raw materials.

Of these, Germany possesses only coal, lime, air, wood and aluminium in abundance or in sufficient quantities. All the others must be imported or replaced by substitutes. Some, indeed, like sulphur, mica, copper, tin, mercury, nickel, chromium, etc., cannot be replaced at all for most purposes, and the whole progress of the war may be said to depend on how much Germany was able to stock before war was declared, on how much can be bought from neutral countries adjacent to her and producing these commodities, and, finally, to what extent her ships can slip through the British blockade, which is very different from the last war. American copper, cotton and petroleum, Spanish pyrites and mercury, Indian mica, Malayan tin, Australian zinc and lead, Malayan and Dutch rubber, South African asbestos, Canadian nickel, African and Polar ores and fats are forbidden her. She is probably getting plenty of invaluable sulphur from Italy, some petroleum from Rumania, Poland and Russia, wood and iron from Scandinavia, wood, leather and magnesite from her Austrian protectorate and Eastern neighbours. She can still obtain some important substances, but by far the greatest number cannot now reach her, except by loopholes in the blockade. It is by withholding them that we hope to end the war. Indeed, were it not that copper is irreplaceable as a conductor of electricity, mica equally irreplaceable as a dielectric, mercury indispensable in explosives and certain technical applications such as temperature control and contacts, vanadium, nickel and chromium in special steel manufacture, and that tallow is no longer a suitable lubricant, our task would be much harder than it is.

Where we enter the organic field and leave the inorganic or metallic field, Germany is nearly completely self-satisfying. This self-support is due almost solely to the fact that during the past 50 or 60 years she has built up a chemical and allied industry second to none in the world and based upon a few raw materials: coal, limestone, salt, air, water and wood. With these, it is no exaggeration to say that some ten or twenty thousand or more different chemicals can be made, ranging from dyestuffs to sugar, from medicinal products to saccharin, explosives and welding gases, perfumes and waxes, fuels and disinfectants, photographic materials, solvents and bleaching agents, fertilizers and synthetic resins, alcohol and synthetic rubber, etc.

Which of the raw materials is most important and the weakest link in her chain is difficult to say. Most people believe it to be petroleum, for Germany produces but a small fraction of her war-time requirements, and the only sources open to her are the Russian, Polish and Rumanian oilfields, and even these are restricted. No doubt, large quantities have been stored, very little has so far been consumed, and private use is cut down to a minimum. When the real war begins, expenditure will increase enormously, and we must not forget that, not only must there be petrol, but also lubricating oils, to drive both tanks and lorries and the wheels of industry. As we point out in the main notes, many valuable materials, fatty acids, solvents, glycerine, alcohol, etc., can theoretically be made from them. It seems doubtful that Germany will expend her most precious raw material on these.

For us in the Plastics Industry the most noteworthy of her achievements is that she is virtually independent of the world for all plastics, with the possible exception of cellulose acetate. Although she had plenty of acetic acid and acetic anhydride for the manufacture, she is dependent on outside sources for her cotton cellulose. Even dependence on this is not certain, for no doubt a war-time quality could be made from wood or straw. We have detailed on another page most of the plastic substances which Germany has been manufacturing for some years past. They form a formidable list.

No doubt there will be need for considerable expansion of the Plastic Industry if there is to be replaced as much metal as possible for constructional and other

work. It will be interesting to see, after the war, how far this expansion of the industry and replacement by plastics has taken place in Germany. No doubt excellent "substitutes" will be used to the full, but there is this much to consider and to weigh the balance finally in our favour. There may be no limit to the theoretical manufacture of substitutes, but, practically, there is. Manufacture cannot expand indefinitely, plant is not infinitely expandable, nor does an abundance of coal or salt in the earth mean an increase of coal tar or chlorine or caustic soda at will. No one can have their cake and eat it.

New Processes and Results

NEARLY three years ago we visited the works of Gestetner, Ltd., in North London, and, with wide-open eyes, saw a hopperful of Rockite phenol-formaldehyde resin being slowly extruded from a remarkable machine into a yard or two of continuous tubing about ½-in. wall and nearly 3 ins. in diameter. This was sawn into short lengths to become the new duplicator rollers that replaced the old "composition" ones made from sulphurized oil.

Once this performance had taken place it needed no great flight of imagination to see that other applications of extruded plastics are possible. The development of this process at Feltham, Middlesex, that has followed, is told on another page in this issue. It is a most promising one. At the same time the method has been applied to urea-formaldehyde resins by British Industrial Plastics, Ltd., and to cellulose acetate.

It will at once be seen that extruded plastics cut yet another wide swath into the metal-using industry and into fields which could not be tackled by normal high-compression moulding, injection, nor its closer approach —cast resins. Although the last-named process can produce a hollow tube, it is restricted at present to the type of mould used and the method of casting. Thin-walled shapes are difficult to produce, and finishing is required.

The life of the cast resin has followed a curious course. Not unnaturally, it first attracted the fancy goods trade because of the transparent and coloured beauty the products possessed. It seems a pity that the liquid resin and the casting process was not considered by chemists and chemical engineers as a raw material and a method for their own problems and as a field for improving the casting process. At present, for example, the liquid resin is merely poured into lead or glass moulds. This necessitates the use of comparatively wide-bore moulds, whereas if it were forced under pressure much thinner and smaller tubes could be produced. Nor has there been any development in this country on the casting of resin containing fillers, such as asbestos and wood flour, concurrent with the use of high-speed accelerators. One obvious objection is the separation of resin from filler during the static curing, but since there would be an outlet for a material that need possess no beauty, there seems little objection to the curing of a casting under motion. That there is a market in the engineering world for cast resins is shown by the work of Dr. Raschig in Germany.

Research on accelerators for resin curing is urgently required, and the need is reflected in a new process that is being developed in the United States of America. It is termed "slush" moulding and seems akin to the spinning or centrifugal method of cast-iron pipe manufacture carried out in this country, which is virtually the agitation or centrifuging of molten metal and its rapid cooling on the inner surface of a mould. A hollow casting or pipe of metal is thus formed.

For resins special accelerators have been developed, and the process has been applied for producing hollow castings for advertisement and other displays. As with the cast resins used for making the more than life-sized figures at the New York Fair we described last year, rubber plays an important part in the method. Latex rubber is sprayed over the model and allow to cure. Then a heavy coat of plaster is spread over the rubber, and when hard the plaster and rubber-lined mould is cut away and reassembled. Liquid resin is then poured into the mould, which is rapidly agitated so that all parts receive a lining of resin. It is stated that after 20 minutes the resin is cured sufficiently to allow for removal. The finished casting can be made ⅛ in. to $\frac{3}{16}$ in. thick, so that the proportion of resin used to the total volume of the finished moulding is small.

We believe that the Kestner Evaporator and Engineering Co. in this country manufactures Keebush pipes by a spinning process.

Registered Trade Marks

SO many readers have asked us to find them the names of the owners of Trade Marks, that we must explain what such a search entails. If the Mark is registered in this country a search is made in the Trade Marks Registry at the Patent Office Library, a fee of 1s. being charged by the authorities for every 10 minutes spent in the search. While we are only too glad to carry out such work to help readers, we are compelled to charge the nominal sum of 1s. 6d. for each search made.

In addition, it must be realized that all Trade Marks are not registered at the Patent Office and so cannot be traced by looking through the *Trade Marks Journal* or the special indexes that are available, so that while the above charge is made, it is no guarantee that the desired information can be obtained.

On the other hand, we have in this office a large index of many well-known registered trade names and if the name in question is on this list no charge will be made.

A stamped addressed envelope must always be enclosed with the request.

POLYTHENE—NOVEL APPLICATION

Closures for Bottles and Similar Containers

Imperial Chemical Industries' new synthetic resin, polythene, has found another ready application. The extreme chemical inertness of polythene, coupled with its retention of flexibility even at very low temperatures, renders it a valuable material for use in closures.

Many closures consist of two parts, the outside cover or cap, which is frequently decorative, and a layer of sealing material inside which acts as a gasket and prevents both leakage and contamination of the contents by the outside cap. Polythene is unique in being suitable for both the cap and the gasket, and is available in forms suitable for injection or compression moulding or as a thin film. Polythene is equally suitable for the flexible ring, familiarly of rubber, seen on screw stops for sealing carbonated liquids.

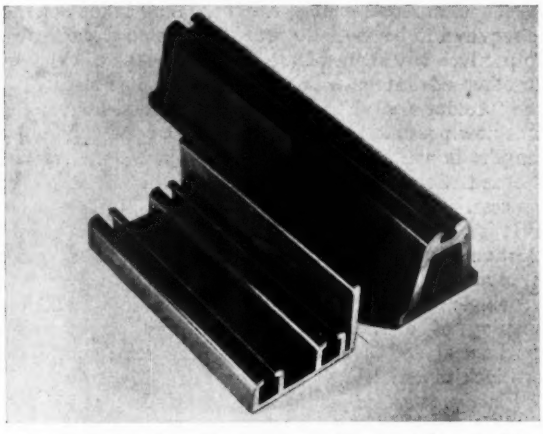
The natural colour of the resin is an opalescent white, but by incorporating dyes and fillers any desired colour effects may be produced. It is an additional advantage that no fading or bleaching can occur by chemical change in the resin.

Extrusion of Plastic Thermo-setting Compounds

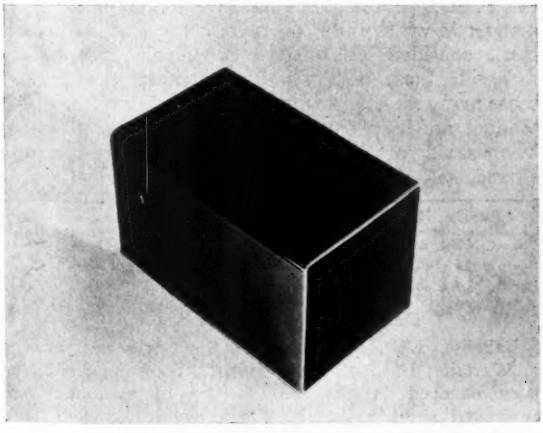
In our June, 1937, issue we published details of what we believe was the first industrial application of extruded plastics in this country—the Gestetner duplicator roller. The following notes on the advances made since are enlightening

EXPERIENCE gained over the past two or three years has led to substantial improvements in perfecting the production of extruded sections in continuous lengths from thermo-setting plastic compounds of the phenolic type by a patented process. In considering the possibilities of this process, particularly as applied to phenolic materials, it may be of interest to briefly outline the method employed.

Broadly, this consists in the forcing of the moulding mixture into dies of parallel internal bore at temperatures so controlled that the heat is greater at the outlet than at the inlet. In its progress through the die, the moulding material is progressively converted from the original powder to its final hardened and accurately dimensioned shape. Braking power, essential to enable adequate moulding pressure to be established within the die, is provided by friction from the moulding material sliding against the die walls, and, to implement this, a special controlling chuck is attached to the outlet end of the die.



Two examples of curtain runner sections: on left, a double type, 50 mm. × 35 mm. overall × 3 mm. thickness; on right, 45 mm. × 51 mm. overall × 5.5 mm. thickness.



A box section extrusion, suitable as a gas-cooker regulator section: 57 mm. square × 1.7 mm. wall thickness.

Production speed depends on a number of factors, but experience shows that this may generally be reckoned at between 3 ins. to 10 ins. per minute for each impression. The use of multiple dies is possible where the required rate of production justifies this, and, of course, where the size of the section allows.

Sections produced by this process by means of hardened and chromium-plated dies require no "flashing," polishing or other surface finishing treatment of any kind, and in this respect are superior to metal extrusions which do not generally emerge from the dies in polished form. So far as accuracy of dimensions is concerned, these plastic extrusions are normally produced to within the same degree of dimensional tolerance as are compression mouldings.

With regard to physical properties, extruded sections in phenolic moulding compounds have mechanical, electrical and chemical properties equal, and in some respects better, than those of compression mouldings produced from the best grade of phenolic moulding powders. These extrusions, therefore, comply in all respects with the requirements of B.S.S. 771 for type "G" materials. Reference should be made to this British Standards Specification for details of the methods of testing, but a brief summary of the more important properties is as follows:—

Ultimate tensile strength	Not less than 5,000 lb./sq. in.	B.S.S.771 Clause 10
Impact strength	0.11 to 0.13 ft./lb.	B.S.S.771 Clause 11
Water absorption	80 to 120 mgm.	B.S.S.771 Clause 12
Swelling after immersion	Not more than 0.003 in.	B.S.S.771 Clause 13
Specific gravity	1.30 to 1.45, depending upon colour	B.S.S.771
Electric strength at 90 degs. C.	Not less than 20 volts/mil.	B.S.S.771 Clause 15
Surface resistivity after immersion in water	Not less than 100 megohms.	B.S.S.771 Clause 16

One point of considerable importance is that extrusions of phenolic moulding compounds are now practicable in varying grades to meet special requirements. The grades which find the widest application are the wood-filled type, and it is these wood-filled grades to which the properties referred to under B.S.S. 771 (type "G" materials) apply.

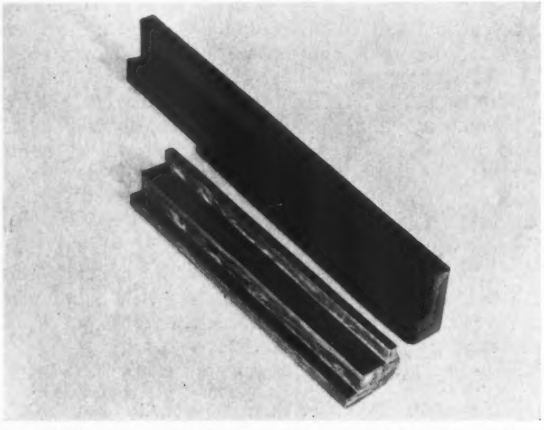
Certain other special grades to which attention may be drawn are:—

Odourless.
High dielectric.
Electrically conductive (graphite filled).
Medium shock-resisting.
Anti-tracking.

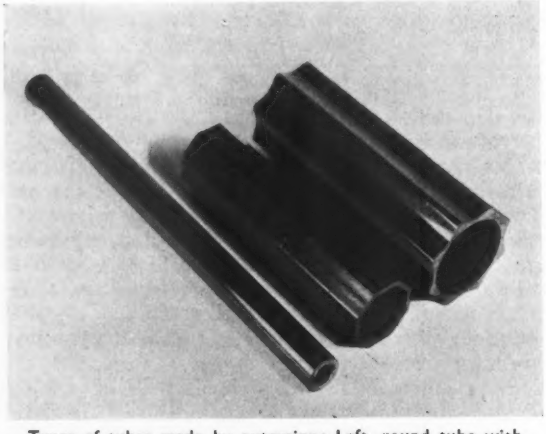
It must be borne in mind that technical problems

arise in the extrusion of these special grades which necessarily limit the range of sections in which they can be produced as compared with the wood-filled compounds, and consequently no generalization is possible, each section having to be considered on its own merits before it can definitely be stated that such-and-such a grade can be satisfactorily extruded in such-and-such a shape.

There are certain limitations in size of rod or bar sections, determined mainly by the size of the special extrusion presses available. The standard type of 50-ton press can produce solid sections up to approximately 1 in. diameter, but for larger dimensions it would be necessary to use a 100-ton press. Experience is as yet limited as to the maximum size in which phenolic extrusions can be produced by a 100-ton press, but it can already be stated that a box section approximately 11 ins. by $\frac{5}{8}$ in. overall, in a wall thickness varying from $\frac{1}{8}$ in. to $\frac{1}{4}$ in., has been commercially produced on this machine, as have also tube sections up to approximately $4\frac{1}{2}$ ins. inside diameter with a wall thickness of approximately $\frac{3}{16}$ in. The accompanying illustrations show some of the more interesting shapes already produced in bulk, and these give a good idea of the wide variety of shapes which this process is peculiarly adapted to produce and which cannot be made commercially practicable by any other method—at least, in reasonable lengths.



On left: profile solid section, 19 mm. x 15.8 mm. overall. On right: beading for table edges, 25 mm. x 12 mm.



Types of tubes made by extrusion: Left, round tube with profiled bore, 13 mm. x 9 mm. Centre, octagonal tube, 25 mm. x 21 mm. Right, fluted tube suitable for lamp standards, 40 mm. across the points, 30 mm. inside diameter and 5 mm. at thickest part of wall.

The range of uses to which phenolic extrusions have been adapted for practical commercial requirements include their use as:—

Kettle handles, where colour attraction allied with non-conductivity of heat is of special importance.
Table-edge beading.
Towel rails.
Curtain runners.
Lamp standards.
Walking sticks.
Torch cases.
Duplicating machine rollers.
Door handles.

One very interesting development which has arisen from the intensive work which Extruded Plastics, Ltd.,* have put in over the past few years is the practical possibility of bent sections. It is well known that completed phenolic mouldings cannot be reshaped, and Extruded Plastics, Ltd., have consequently perfected a process whereby bending takes place during the actual extrusion, i.e., before curing is completed. This bending process can be effected to a radius equal to 15 times the cross of the section concerned; that is to say, a tube in 1 in. outside diameter can be bent to a radius of 15 ins.

Special reference should also be made to the almost unlimited possibilities of tube production, where, to meet special requirements, either the bore or the exterior is required to be specially profiled. It is now practicable to produce any shaped bore with any shape of exterior. Another advantage which must not be lost sight of is the "colour appeal" which phenolic plastics have, and it is now possible to produce these extruded continuous lengths in various mottles in much the same way as mottled effects are obtained by the injection moulding process.

It is correct to say that the extrusion method of production as outlined helps to fill the gap between the use of moulding compounds shaped under heat and pressure in single or multiple impression steel dies, and the shaping of articles on turning lathes or by other mechanical and hand tools from the solid rod, sheet or block material.

Finally, it seems justifiable to conclude that the possibilities opened up by this process call for close attention, especially under present-day conditions where the supply of metal or even of wood is hard put to it to keep up with the ever-growing demand. They show this plastics process as another clear illustration of the manner in which the Plastics Industry is fitting itself to merit consideration of its ever-widening possibilities, alongside those of the older materials, especially in those many directions where the properties of the plastic product are fully equal to practical requirements, and where saving of weight is not the least of the advantages offered.

* Extruded Plastics, Ltd., is a subsidiary of Cellomold, Ltd., of Feltham, Middlesex, for whom F. A. Hughes and Co., Ltd., of Abbey House, Baker Street, N.W.1, are sole distributors.

Bakelite Acquires Warerite, Ltd.

Bakelite, Ltd., have acquired the works and business of Warerite, Ltd., of Ware, Herts. Warerite, Ltd., have been engaged in the manufacture of synthetic resin laminated sheet materials. This acquisition will assist Bakelite, Ltd., to meet the growing demands for Bakelite laminated.

The Entente and Co-operation

Mr. Stanley Miller Advises the French Aircraft Industry on the Use of Cellulose Acetate

THE article on "Cellulose Acetate in Aircraft Manufacture," which we published in our February issue, has created a great deal of interest, not to say enthusiasm. It brought round to these offices Mr. Stanley Miller, the well-known expert, who had a great deal to tell us on the matter and, indeed, opened our eyes to the fuller possibilities of the material, to the extent to which it had been applied in this country and the difficulties encountered in attempting to introduce it to an industry such as the aircraft world, against the proverbial conservatism of the Briton.

But Mr. Miller also told us another story—of a very successful attempt to introduce the wider use of plastics, especially cellulose acetate, into the French Air Force by showing what had been accomplished so far in the R.A.F.

It is commonly supposed that the French aircraft industry, who have long been pioneers in design and holders of many air records, would know everything that has been done in other parts of the world in the matter of components development, especially where replacement of metals by plastics is concerned. That this is so, is strange from the scientific development point of view, but not so from the economic point of view, because the necessity for finding replacements has not been so vital to the French as it has been to us. The French light metal industry, for example, is one of the strongest and most developed in the world.

The development of plastics—or, rather, their application—has not proceeded with the speed we should expect in a country that not only produces a great deal, but, in the case of cellulose acetate sheet, far more than we do in this country, which on the face of it seems anomalous. However, French designs departments know what they want when the time comes to effect the change. Moreover, the French Ministry of Supply is beginning to make its presence felt, and has asked that due economy in metals should be observed and that increased strain, due to increased production, should not be exerted on the metal industry.

In the meantime the famous concern Usines de Rhône-Poulenc had been wondering why so little of their acetate sheet had a sale in the French aircraft industry, when they were sending so much to Great Britain for aircraft purposes. This led to meetings between this concern and the French Air Ministry, and, logically, inquiries were made of Messrs. May and Baker, Ltd., the English agents of the Usines de Rhône, as to where and why acetate sheet was being used in British machines. This information was supplied, and it was then necessary to go into greater details and show the French factories the mechanics of production. An expert liaison officer was required for the job, and Mr. Stanley Miller was chosen. As many readers may know, he is not only an expert in the applications and use of plastics generally, especially where aircraft is concerned, but he also developed the first components ever made in black acetate sheet in this country.

The British Air Ministry gave every facility to Mr. Miller to assist our ally in this work, and in due course he left England by air laden with some 60 representative examples of components in use and in production in this country. We think it only right at this juncture to record the thanks of the French Air Ministry and of Usines de Rhône to the English concerns—The Hadley Co., Ltd., Thermo-Plastic Products, Ltd., G. H. Gregory and Co. (Plastics), Ltd., and Foster Wikner Aircraft, Ltd.—who unhesitatingly supplied some of the most interesting mouldings ever produced, and by doing so assured the success of the visit.

On arrival Mr. Miller found that arrangements had been made to hold an exhibition of these parts in a large room in the Société des Matières Plastiques, and that designers, production managers, technical directors, representatives of the plastics industry, of the aircraft industries, of the Press and of the Air Force itself had come to learn from all parts of France.

After full time had been given to inspect each moulding closely everybody retired to an adjacent conference room, where the applications of black acetate sheet were discussed. Addresses were given by directors of Usines de Rhône-Poulenc, by officials of the Air Ministry on (1) the material and (2) what it is being used for and why in the British aircraft industry.

Mr. Miller examined analytically each part in succession, explaining points such as weight and cost, method and speed of production, and comparing each with its counterpart in metal. It was at once admitted that we were much ahead of the French in this application.

So much was there to impart and to learn that those in the aircraft industry expressed the great urgency for him to repeat the whole exhibition and talk to the drawing office staffs and production departments of their respective companies.

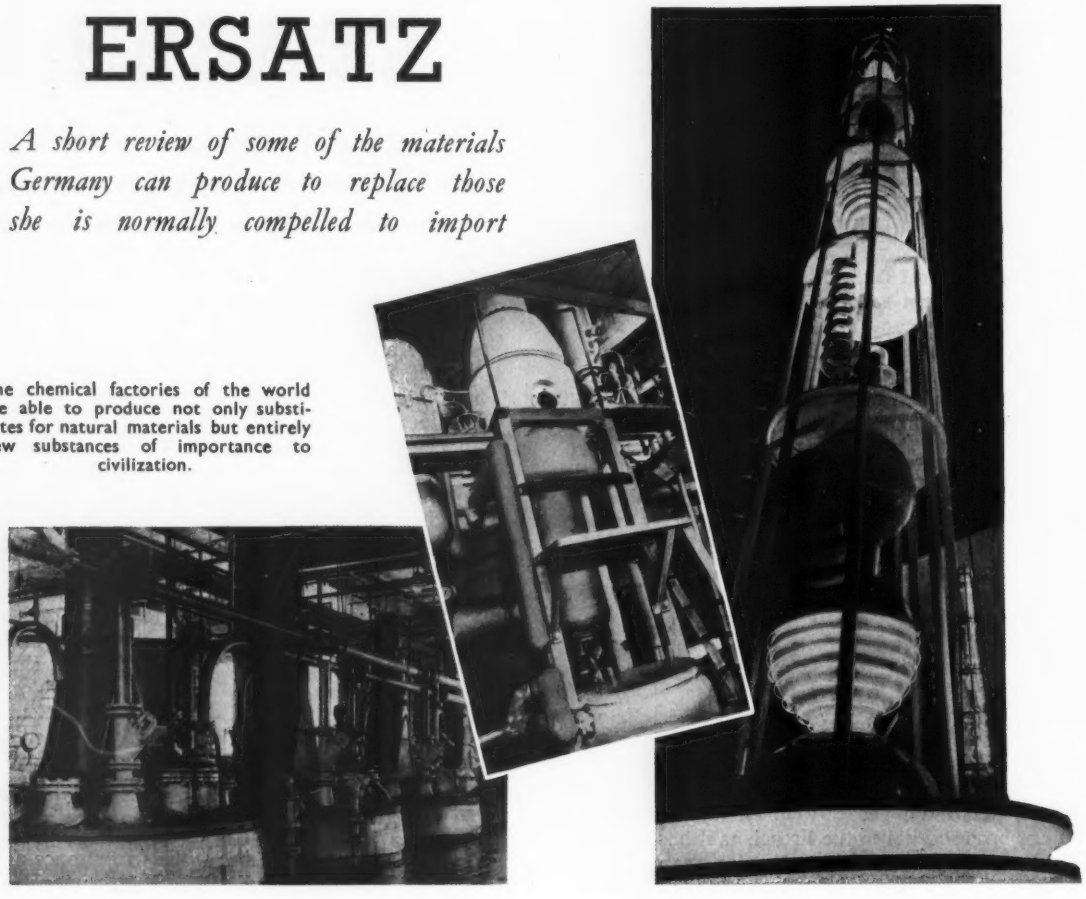
Mr. Miller went to France for a four-days' stay, but he remained for 18, and in that time went to several of the leading companies' main factories and repeated the valuable work he had been doing in England for over two years. Before leaving he had organized the installation of plant in factories that were to produce components in black acetate sheet. We understand that manufacture of most of those developed here are being adopted in France, and when the production is fully organized Mr. Miller will return there again to complete the work he started.

It is especially interesting to note that, of all the aircraft components taken over by him, the one that acted like a magnet to all designers and officials of production departments was the machine-gun ammunition chute made by The Hadley Co., Ltd. Here is an item which caused much worry on French aircraft, as, of course, it did in ours until the plastic chute had been adopted. It overcomes all the disadvantages of chutes made in any other material and possesses the additional advantage of resilience and strength, ease of production and ease of repair. To us it is especially pleasing, since it was in this journal that a photograph and description was first published.

All in all, this story of perfect collaboration between this country and our ally is most heartening, and it gives us great pleasure in repeating it.

ERSATZ

A short review of some of the materials Germany can produce to replace those she is normally compelled to import



The chemical factories of the world are able to produce not only substitutes for natural materials but entirely new substances of importance to civilization.

A READER of our notes last month on the new German laws restricting the use of plastics has asked us if we can publish any information on the general use of ersatz material, plastics and otherwise, in Germany and thinks such a list ought to be in the hands of our Government so that, where necessary, we can take a leaf out of the enemy's book. He also asks with reference to the German restrictions "What ersatz will the Germans use instead of the forbidden ersatz?"

Dealing with the last question first, we haven't the faintest idea. The laws forbidding the use of phenolic resins in the fancy goods trade, for example, will kill a big industry and a big export trade in Germany, for metal and wood are much more scarce. It may be there is a great scarcity of phenol, which we cannot quite believe, unless it is that most of it is being made into picric acid. We should say that there is not much synthetic phenol made in Germany, as the benzene for it is so urgently needed for fuel purposes. Alternatively, the German leaders in war time probably do not consider the fancy goods trade worth while maintaining.

As for the first request, it is not only outside the sphere of this journal, but also a tall order and we certainly cannot make anything like a complete picture. However, we believe it is important and nowhere have we seen a comprehensive review of "ersatz" materials.

But first let us have a little philosophic discussion of the matter.

The dictionary says the word "ersatz" means "an equivalent or substitute," and if the world were able to speak languages correctly, much trouble would be avoided and many industries would benefit. The word "ersatz" in the ears of an Englishman means something inferior, as do the words "substitute" and "artificial." Presumably it is because many artificial materials have been made by chemists and other scientists by such remarkable processes that they were cheaper than the natural products they replaced, and generally in the experience of the world a cheaper material is inferior to a more expensive material of the same type. The greatest harm done by indiscreet nomenclature was the calling of what is now known as Rayon by the words "artificial silk" or "silk substitute." It put back the Rayon industry by about 20 years. If the early workers had understood that it was not a real substitute for silk and had declared to the world that here was Rayon, or some other name—a new and low-priced textile, the road to fortune would not have been delayed. Where a more modest and truthful declaration would have proved fruitful, a deliberately false one soon "blew the gaff" under close examination. We might point out that the modern American method they are applying to the new textile nylon is correct and worthy of success. Nylon is nylon and not substitute something or other. As well call aluminium "steel substitute" because light metals are replacing steel in aircraft manufacture.

We prefer, so far as this journal goes, to regard and talk of the word "substitute" as a real equivalent or even something better. It would be best not to use the word substitute at all with regard to plastics; we

consider them merely new materials of construction and deal with them accordingly.

In to-day's paper we read that there is a most remarkable substitute now on sale in Germany, namely, butter perfume. It is claimed that two or three drops of this poured on some food gives the impression that it has been cooked in real butter.

There is nothing remarkable at all in this, for synthetic butter perfume (it is probably a derivative of butyric acid) is as old as the hills and is used in all countries, as any butter blender will tell you. There is nothing dangerous in its use, nor abnormal. Pure and wholesome butters at certain periods of the year have little natural perfume and there is no harm in adding a tiny quantity of a synthetic perfume exactly equivalent chemically to the natural material if the public demand the odour. When this perfume is added to tainted butter to hide a rancid smell, then it is a serious business and a legitimate use becomes a criminal one. When the addition is to pretend that food is being cooked in butter, the idea is merely idiotic, if the action is done en famille, or, again, verging on illegal if it is done in a restaurant to cheat the public. We should imagine that this practice is as common in Soho as it is in Berlin.

Chemistry has often provided the wherewithal to deceive, deliberately and otherwise, the mass of the public by using substitute materials. The deception is generally a harmless one and is carefully controlled, in the case of food, by stringent laws. Kippers and peas, for example, may be coloured with a substitute for the natural colours.

Many years ago the writer was employed in making paraffin wax, among other things, in a foreign country. We used to mix the wax with a little dye and some synthetic beeswax perfume, so as to simulate natural beeswax for sale as candles to the Catholic churches. Our readers may worry out for themselves how immoral this act was and whether the paraffin wax was a genuine substitute.

A more difficult example to correlate is what is generally called butter substitute, or margarine. When margarine was first produced in the Franco-Prussian war it was certainly not an equivalent of real butter. To-day the manufacture is so carefully controlled and its quality so excellent that, when combined with vitamins, it approaches closely to the natural material, so closely indeed in actual food value that it may be considered as an equivalent and therefore a real substitute. Some day it may be regarded as being more than a food for poor people only.

Again in a recent paper I note that the German Patent Office has received over a thousand applications for patents for coffee substitutes. There seems nothing very terrible in this, as the mere attempt to alter the taste for a nation's beverage does not seem harmful. I have yet to know that coffee has any food value and a German chemist might easily be able to "put across" a mixture of chopped and singed hay, with a dash of caffeine, and so produce a nice stimulating drink.

If we go to the Imperial War Museum in the Lambeth Road we find an interesting little corner devoted to German ersatz materials of 1914-1918. The exhibits are not numerous and they are not (except where rubber is used) of plastics.

Boot Soles. Wood was used for this purpose and for heels. Soles were also made of refuse rubber. There is nothing strange or interesting in these uses, except that it gave us information that Germany was running short of leather and rubber. Besides, there is no information as to how widespread this use was. Old tyres and other refuse rubber are reclaimed in this country during peace time.

Boot Laces. There are examples of these made of paper and of wood pulp.

Machinery Belting. There is also a sample of this belting made of paper, which, in the woven condition, can be fairly strong. The life of the belt, however, could not have been long. This was obviously a retrograde step for German industry.

Canvas, Cord and Twine. These were also made of paper, as were some samples of ladies' hat material.

Finally, there were specimens of "cotton" goods stated to be spun from Textiline, a flat paper yarn invented by a Swiss and manufactured in Switzerland in 1918.

Altogether, there is not much in the above list that could be called a genuine substitute under our own definition of the word. They are all examples of poor replacements for the material Germany was deprived of under war conditions.

To-day the story is very different and Germany is turning out of her chemical and plastics factories materials that are substitutes in the real sense of the word, except that some are not economically considered worth while in a non-totalitarian state. They are, however, often used for exactly the same reason they are used in this country, namely, the substitute is a material better than that which it replaces. In fact, the German plastic industry has done exactly what the British counterpart is doing—to induce manufacturers to realize that plastics are new raw materials of construction worthy of consideration.

Some of her substitutes are merely replicas of natural compounds made by chemical synthesis or other processes.

Thus, until recently the world has been content to produce glycerine from vegetable and animal oils and fats; in fact, during soap making glycerine is produced at the same time. During the past 10 or 15 years chemists all over the world, British, American, German and Japanese, have issued patents for making glycerine from molasses. It is possible that Germany is making this very desirable material from such molasses as she may have from her own sugar-beet industry. Whether she has enough molasses for this and also for alcohol and other solvent manufacture which also use molasses, is difficult to say. We in this country import very large quantities. On the other hand, she may be manufacturing glycerine from the gases made from cracked petroleum oils. In addition there are many compounds which can be used instead of glycerine for some purposes. Among these are glycol, butylene glycol, penta-erithrit, mannitol and certain higher alcohols.

Another manufacture which has been established in Germany for some 10 years on a small scale is the production of sugar from wood by treatment of this with hydrochloric acid. Actually, the sugar produced is glucose, not sucrose (ordinary sugar), and is limited in application. However, it is a sugar, and a very useful one.

Claims have also been made for a new drying oil replacing linseed oil, so widely used in paint and varnish manufacture, the seed of which is not grown in Germany. There are many patents for making such oils from petroleum, but since Germany is hoarding

petroleum for other purposes there seems little chance of it being manufactured by this means. We do not know the life and weather-resisting properties of paint films made from this oil. Since vast quantities of linseed oil are also used to make linoleum, it is interesting to note the efforts Germany has made to produce a substitute from Mipolam, the well-known vinyl-chloride plastic. We saw examples of floorcloth made from this material at Leipzig Fair last year and, although probably very expensive, it looked more beautiful and apparently has better wearing qualities than linoleum. Mipolam, which is made from acetylene, also replaces leather in many applications and is not a poor substitute either. It is also being made into a canvas-like material for the filtration of chemicals.

Fats and fatty oils themselves have been made in the chemical laboratory, if not already in the chemical factory, but whether this would prove any relief to Germany and so avoid the necessity of importing them is a matter of conjecture. To make an artificial fat we must join together two compounds, one a fatty acid and the other glycerine. Both glycerine and fatty acid can be made from non-fatty sources, the former, as already indicated, from molasses or petroleum gases and the second by the oxidation of a petroleum paraffin. Since, however, Germany has little petroleum or molasses to spare, there is little possibility of such manufacture. The Japanese have claimed to make a synthetic butter from waste fish oils by extraction of the fatty acids and reuniting them with glycerine. Likewise, a drying oil simulating linseed oil for paints has been made by oxidizing a fatty acid obtained by treatment of petroleum oils and then combining it with glycerine. On the whole, these methods of producing fats seem very roundabout and expensive methods of producing something which is readily available in nature in peace-time and which can only be considered in war-time. It is more probable that Germany will rely more than ever on the nitro-cellulose type of lacquer for protective films, on such mineral and other oils as she can treat or on simple films made from oil-less synthetic resin solutions or their emulsions. In passing, it may be noted that in addition to the artificial resins available for paints there is a synthetic shellac.

Pigments are, on the whole, being severely restricted to those which can be obtained within the country. Germany is trying to do without lead containing pigments and uses zinc oxide and barytes and iron oxides as much as possible. A significant move a few years ago was the beginning of the manufacture of carbon black from naphthalene produced from coal. At the same time it must be admitted that this removes part of the naphthalene which is so widely used to make phthalic anhydride for the production of alkyd resin, now so important in varnishes and paints.

Serious shortage of wool is probably already existing in Germany, and it may be that here the first and outward signs of deterioration may be seen. But it will be far from the paper-using days of 1918. As long as large quantities of wood pulp are available (cotton must be far more restricted in Germany than it is here and is earmarked for explosives), and as long as quantities of the Tiolan and Lanital types of fibre are available, either from home-produced casein or Italian sources, the textile industries will not suffer as they did in the last war. The absence of wool is a great drawback, but it is far from being fatal.

As for "substitute" petrol, most people know a great deal of this. It is made by the hydrogenation of brown coal or from water gas in Germany in fairly large quantities. As in this country, quantities of fuel of the benzene type are made during the manufacture of coke and town's gas. Neither the German nor the British synthetic material, similarly produced in the North of England, is what is normally called an "economic" proposition. They are war measures and are heavily subsidized so that they may reach the market at the price of the ordinary material.

As for plastics, there is little more to relate, since this journal has noted since its inception the wide use of these materials for purposes where metals can be avoided.

The types that have been developed especially are those which can be made from German raw materials.

Phenolic Resins.—Made from (1) phenol, obtained directly from coal tar or by synthesis from benzene, also a coal-tar product; (2) formaldehyde, made from wood by distillation or from methyl alcohol, which, in turn, is made from water gas.

Urea Resins.—Made from urea and formaldehyde, the former being produced by the interaction of carbon dioxide and ammonia derived from the air or coal tar.

Synthetic Rubber.—Made from acetylene produced from carbide, in turn made from coal and lime.

Vinyl Resins.—Also made from acetylene.

Styrene Resins.—Made from benzene.

Acrylic Resins.—Made from ethylene and benzene, both obtained from coal, or from acetone.

Aniline Resins.—Aniline is made from coal.

Coumarone Resins.—Coumarone is obtained from benzene.

Cellulose acetate has never been given great prominence in recent German exhibitions, for she realized that cotton would be difficult to obtain and would be reserved for explosives. There is a huge list of synthetic materials, such as camphor, softeners, solvents, etc., which are subsidiary to the plastics industry and which are made from German raw materials. Presumably, Germany has enough native turpentine to make synthetic camphor and rosin.

On the whole we should say that Germany has long decided which materials must not be made in metals for example, and that manufacturers have been forced to accede to rulings from above. In this country we are very lax and even milk bottles are capped with aluminium foil when for years cardboard discs have been quite efficient. Surely during war-time this could be stopped, especially as we know that many aluminium users cannot get metal for far more important jobs.

We suppose metal tubes for toothpaste and the hundred and one other medicaments have largely disappeared in Germany and are being replaced by a plastic material.

We presume, also, that metal pipes are being replaced wherever possible by the vinyl-chloride or synthetic-rubber type of plastic, and if there is any motorcar industry left in Germany we are sure the Auto Union and D.A.G. are utilizing plastics. The last we heard of these firms was that they had produced a complete body, with the exception of the bonnet, from a Lignofol or impregnated-canvas type of material.

The radio industry may not be suffering from a real shortage of wood, for although mahogany and rare woods must be imported, there are plenty of hardwoods in adjacent neutral countries.

Whatever the situation, however, the plastics industry in Germany must be booming. Plastics have been a godsend to her, or, rather, they have been more highly developed there with war as a probability.

CHLORINATED RUBBER

Crepe rubber used at the Hercules plant for the manufacture of chlorinated rubber.

THE Hercules Powder Company, Incorp., U.S.A., has provided us with the following answers to pertinent queries regarding chlorinated rubber, and as we feel that a question and answer discussion serves a useful purpose, we have decided to retain it in its original form.

What is chlorinated rubber?

It is a distinctive, quick-drying, film-forming, thermoplastic synthetic, suitable for use in protective coatings, adhesives, plastics, printing inks and a great variety of other materials.

What is its chemical composition?

It is made from the reaction of chlorine and rubber. Each molecule is completely saturated and consists, approximately, of 67% chlorine and 33% rubber.

In what form is it produced?

As a white, stable, odourless, tasteless, non-toxic, non-inflammable, granular powder, with a specific gravity of 1.57-1.64.

What is the appearance of solutions and films?

Solutions are clear, water-white and free from haze; films likewise are clear and colourless, similar to those of nitrocellulose.

What types are available?

Chemically there is, of course, only one type of chlorinated rubber. It is available, however, in a number of viscosities; thus, a viscosity of 5 centipoises is very suitable for printing inks; 10 centipoises for high solid lacquers and as a fortifying agent for alkyd resins and oleo-resinous varnishes; 20 centipoises for general protective coating use and for fortifying alkyd resins and oleo-resinous varnishes; 125 centipoises for concrete floor paints, paper lacquers and adhesives and 1,000 centipoises for textile finishes and other finishes requiring a maximum flexibility.

How is chlorinated rubber used in protective coatings?

Broadly speaking, in three ways:

1. As a major ingredient of finishes. In this use it acts as the chief film-forming ingredient, in much the same way that nitrocellulose serves as a lacquer base. Small amounts of platicizers, resins and pigments are added as required.
2. In small percentages to reinforce other finishes, such as oil paints and varnishes. In this capacity it speeds the drying and improves resistance to chemicals.
3. As a mixture with long-oil alkyd synthetics to produce quick-drying synthetic finishes.

Is its chemical resistance unusual?

Yes. No other finishes equal chlorinated rubber finishes in both alkali and acid resistance. When properly compounded, chlorinated rubber finishes resist 50% ammonium nitrate solution, 5 to 50% sodium hydroxide, 5 to 70% sulphuric acid, 85% phosphoric acid, 10% hydrochloric acid, 10% nitric acid, bleach solutions, corrosive gases, mineral oils, gasoline, salt water, water and many other corrosive influences.

Where are these finishes suggested for use?

The combination of quick-drying and chemical resistance is responsible for the wide use of chlorinated rubber finishes, indoors and outdoors, in industrial plants, on hardware, machine tools, steel products, railroad rolling stock and for marine finishes, paper coating, cloth coating and many other uses.

Why is it so highly recommended for most concrete-type surfaces?

Chiefly because it dries quickly, even in the presence of moisture; it also resists alkali, which is present in materials of this type, especially "green" concrete. The surface should be carefully prepared; dense concrete floors should be etched with 10% hydrochloric acid before painting.

Why is it especially suitable for paper lacquers?

Because it makes possible an odourless, tasteless, flexible, non-toxic, high-solids coating, with the added advantage of moisture-vapour-proofness. This market is being explored vigorously; many important applications already have been made.

How does chlorinated rubber improve printing inks?

It shortens drying time, improves body, imparts chemical resistance and adds to water and moisture resistance.

Is it used in plastics?

Although chlorinated rubber is a true thermoplastic, it has not yet found any important commercial applications; however, experimental works show interesting

possibilities. For example, certain mixtures with thermosetting plastics have been successfully moulded by the injection method.

What are its advantages as a plastic?

Resistance to alcohol, mineral oils, acids, alkalis and corrosive influences; its almost complete absence of water absorption; also shortening of curing time in thermosetting resins.

How are chlorinated rubber plastics formed?

Plasticizers, resins and colouring matter are added in much the same way as they are added to cellulose esters.

What is the present position of chlorinated rubber?

Chlorinated rubber has been widely accepted for industrial use. In protective coatings, especially, it has earned a distinctive position as an important ingredient on many types of finishes. Many paint, varnish and lacquer manufacturers are using it either separately or as a reinforcing material. In other fields it is likewise well established.

What is its future?

Because of its inherent properties, together with its rapid acceptance by industry, and because of the remarkable improvements made in quality, its future is most promising. There is every reason to believe that it will continue or surpass its remarkable rate of growth which distinguishes it even to-day as an important raw material.

VINYL RESINS FIND NEW USES

ACCORDING to *The Rubber Age*, U.S.A., calendered sheets of "Vinylite" plasticized resins, which are said to have many of the advantages and few of the disadvantages of leather and rubber, have been developed by the Carbide and Carbon Chemicals Corp., a unit of the Union Carbide and Carbon Corp., New York. These sheets are also said to offer possibilities for numerous applications heretofore not achieved by the plastics industry. The material, suitably plasticized co-polymers or vinyl chloride and vinyl acetate, can be supplied colourless or in transparent or opaque colours.

The new, highly plasticized materials are flexible to the point of withstanding folding and repeated flexing. Elongations up to 250 per cent., with a tensile strength of 3,000 lb. per square inch, are readily obtained. The sheets are unusually tough and show interesting elastic properties. Stretched appreciably, the sheets return slowly to their original dimensions.

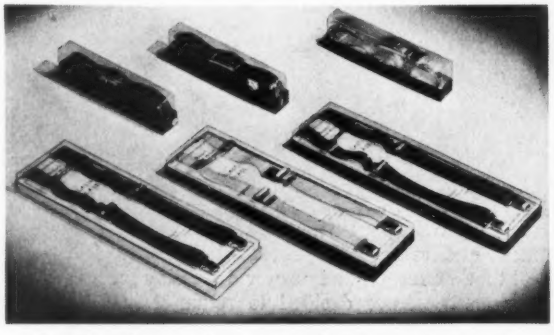
Because of their unique decorative possibilities, strength and permanence, large quantities of sheeting of this material have already been produced for the manufacture of men's belts, wrist watch straps, garters and similar articles. It is claimed that articles made of the plasticized resin last longer than articles of the usual elastics, leather and other materials. Because of correct "feel" and suitable "give," articles of the new material require practically no adjustments over a period of months.

Regarding permanence, the new materials will not oxidize or crack, nor are they affected by mould or mildew. They are completely resistant to water and perspiration and will not discolour or develop any odour from moisture absorption. Depending upon the plasticizers used, they can be made highly resistant to oils, greases, gasoline and alcohol. The plasticized sheets are thermoplastic, which permits an easy, permanent bond by means of a rapid heat-sealing operation.

The new materials are made in thicknesses ranging from film approximately 0.003 in. in thickness up to almost any thickness desired. Stocks in thicknesses from 0.003 in. to 0.090 in. are available.

These new vinyl resins are now being used by a well-known American concern, S. Buchsbaum and Co., for the manufacture of belts. The vinyl resin is readily fabricated and, in addition to its novel and attractive appearance, it has a high elasticity which makes it particularly suitable for use in the belt, brace and garter field. Another outstanding advantage is the ease with which it can be rendered free from soilage and its high resistance to wear. The material is not only exceptionally tough, but since the colour penetrates right the way through, any abrasion that does occur is not visible to the eye.

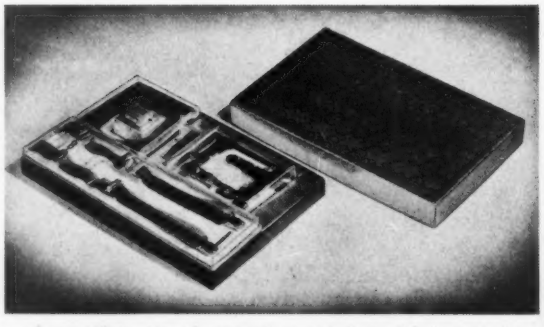
The use of vinyl-resin sheet for this purpose is significant, as it illustrates that manufacturers are becoming cognizant of the possibilities of plastics as direct competitors of standard materials. The new synthetic materials combine attractiveness, due to colour or transparency, with excellent wearing qualities and possess an exceptionally long life.



Samples of suspenders made of the new vinyl resin sold in the United States by S. Buchsbaum and Company.

At the moment the novelty of plastics is responsible for a large proportion of the sales, but when this initial phase has passed the goods will be sold purely on merit.

Apart from the use of vinyl resin for various purposes in the men's-wear trade, it is suggested that plasticized vinyl resin could be used with equal success in the women's trade for belts, hat decorations and even handbags. It would appear to be ideal for the purpose.



A complete set of suspenders and belts fabricated of vinyl resin and packed in a new "see-all" pack. Incidentally, the transparent cover for the cardboard pack is also made of vinyl resin.

Ideas—

By the EDITOR

Plastic Bookshelves

The idea of the moulded bookcase is, of course, not a new one, but I contend that it only comes within the sphere of practical economics when the bookcase is comparatively small and in special circumstances. It was when I had turned over the last page of my last Penquin thriller, and had duly witnessed the hanging of the villain and the reunion of the falsely accused hero and the heroine who had always believed in him, that it struck me that here, in truth, was a fit and proper field for the plastics industry. The Penguin and similar series have now become a real part of the life of the country and will remain so for many years to come. Here seems a good opportunity for a small bookcase made on the expanding plan. A case made about 12 ins. wide by 8 ins. high and about 5 ins. deep would be large enough to carry about 20 volumes and would be of a convenient size for manufacture by many moulding concerns. The provision of slots or recesses and bosses to make multiplication possible would be a relatively easy thing for the moulder.

The time for such a case seems very opportune at the moment, especially since wood is almost unobtainable.

Suitcase Handles

About a year ago or more I had news that an English moulder was producing, or about to produce, suitcase handles of moulded plastics. I was very excited, since, as I noted in my January "Ideas" page, Dr. Skirrow, of Shawinigan, Ltd., had once told me that such a handle would one day be made. Judge my disappointment when the English moulder told me I could on no account give it any publicity. This is a pity, for I should liked to have pointed to a British concern as being the first to produce such handles. However, we have been forestalled by its manufacture in the U.S.A. Allied Plastics Inc. are moulding them for the makers of the well-known Halliburton travelling cases from Tenite, the cellulose acetate made by the Tennessee Eastman Corporation. Or it may be of cellulose aceto-butyrate, which is stated to be rather stronger. The handles are injection moulded and are made to resemble tortoise-shell.

This handle, in fact, now makes possible the complete plastic suitcase, for readers will remember that in our January issue we gave prominence to the fact that a suitcase made of laminated material was now being placed on the market in the U.S.A. It is true that "there is nothing like leather," but it is equally true to say there is nothing like plastics.

Match Boxes

Somebody important has been writing to the *Evening News* about the waste of wood to the nation by continuing with the habit of using wooden matches and wooden match boxes. By calculating the number of matches he uses to light his pipe per day and multiplying this by 365, and again by the number of pipe and cigarette smokers in the country, he has estimated that we could save an enormous tonnage if the match were made shorter or, alternatively, had two heads. And, again, instead of wooden match boxes he suggests that plastic match boxes should be made and that matches should be sold by tobacconists in little bundles, to be put in the plastic box. This wouldn't be bad for the plastic industry at all, although Heaven alone knows where all this raw material is to come from. I should also like to know how he's going to tackle the replenishment of the rubbing surface on the box. It only lasts about 100 to 150 matches.

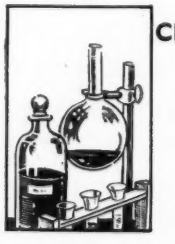
Jewel Cases

It is a strange fact, probably a residue of our waxed fruit and antimacassar Victorian days, that jewel cases, especially the smaller variety for containing rings, have almost always been enveloped with a plush covering. We are not sure whether the death-knell of plush has been finally sounded, but the plastic box is now well established, as the accompanying photograph shows. Ivory in appearance and clean to handle, we hope it presages the end of the bad old dust-collecting era.

WORLD'S INDUSTRIAL

TEXTILES

Laminated textile fabrics described in the *Textile Weekly*, Feb. 2, 1940. The production of a satisfactory laminated fabric calls for a bonding material which is not softened by hot water, will flow to the required degree when subjected to pressure for a short time at some higher temperature (140 degrees to 200 degrees C.), will not decompose or char at this higher temperature, is free from skin-irritating action, is unaffected by alkaline detergents, is not discoloured by sunlight and retains its initial high flexibility under normal conditions of wearing and washing. In the plastics field the vinyl resins with the best all-round properties are those resulting from polymerization under rigidly controlled conditions of a mixture of two liquid monomeric-vinyl compounds. This is the process now known in general as co-polymerization and the most celebrated example of its application is the co-polymer of vinyl acetate and vinyl chloride, which possesses unusual interest to the textile industry because the new vinyon yarn is a vinyl resin based on the same principle. Several examples of co-polymer resins as bonding agents for laminated fabrics have appeared in the patent literature of recent years. An adhesive layer for semi-stiff collars was prepared by T. H. Swann and Cluett, Peabody and Co., Inc. (E.P. 473,478, 1937), by applying a solution of co-polymerized vinyl acetate and vinyl chloride to an interliner of cheap cotton fabric (4.7 oz. per yard, 49 warp threads and 54 weft threads per in.). After this had been allowed to dry it was assembled with the outer plies (broadcloth or Madras) by stitching before applying heat and pressure. A co-polymer of methyl methacrylate and vinyl chloride is proposed by the Deutsche Celluloid Fabrik (French patent 819,049, 1937) in the manufacture of washable collars with an interliner of cloth. Individual vinyl polymers or their mechanical mixtures have also been proposed as bonding agents, since it is possible to overcome their brittleness or other undesirable features by blending with plasticizers or polymers of low molecular weight. Co-polymerization is the process of choice when the presence of a plasticizer might detract from some special quality, such as the unique dielectric strength of polystyrene. In the case of laminated fabrics for ordinary wear, however, there can be no objection to the use of a suitably plasticized polystyrene. The alkyl phthalates appear to satisfy the requirements of a polystyrene plasticizer for bonded fabrics, being resistant to the solvent action of hot water and non-volatile at the bonding temperature, while they are not readily saponified by alkaline detergents. A coating solution for the cotton interliner in the process of T. H. Swann (English Patent 473,478) consists of 8.5 parts polystyrene, 1.5 parts diethyl phthalate, 85 parts benzene and five parts xylene. The first commercial laminated fabric contained cellulose acetate and work has gone forward steadily in the past few years with a view to eliminating some of its weak points. A class of esters which retain their adhesion to fabrics and resiliency after repeated laundering to a greater extent than ordinary cellulose acetate are the mixed lower-aliphatic esters of cellulose. Typical members are cellulose acetoproprionate and cellulose acetobutyrate, the application of which as bonding layers is claimed by H. W. Klinger and the Hercules Powder Co. (U.S. patent 2,170,416, 1939). This patent specifies an acetoproprionate containing 10 per cent. acetyl and 34 per cent. proprionyl, or an acetobutyrate containing 26 per cent. acetyl and 13 per cent. butyryl. The bonding layer may take the form of a continuous film of the mixed ester or of a cotton, wool or rayon fabric coated with the ester. Synthetic resins derived from petroleum which are coming into prominence in the plastics and synthetic-rubber industries are the polyisobutylenes (e.g., Vistanex and Oppanol produced by the Standard Oil Co. and the I.G. Farbenindustrie respectively). They have also been put forward as components of laminated fabrics, and the Standard Oil Development Co. (E.P. 479,478, 1938) recommend a polymer with a molecular weight of 200,000 in admixture with a small proportion of rubber for this purpose. **New sources of cellulose** discussed by L. G. S. Hebbs in J. Soc. Dyers and Col., 1939, 55, 550-559. The production of cellulose pulps from various sources, including straw, bamboo, pine, eucalyptus and soya-bean for paper and rayon manufacture is reviewed. Southern pine krafts are being produced in the United States, but they have inferior strength to Scandinavian krafts. The rapid-growing Western hemlock is used for both paper and rayon, being easily converted into good colour pulps and having a low resin content. Pulps from straw and bamboo are degraded and impure and are difficult to use for rayon production. Spanish grass pulps are receiving considerable attention in Italy as a material for rayon, whilst in Germany beechwood pulps are being utilized for staple fibre production. Analytical figures are given for many of the pulps discussed. **Non-cohering, transparent sheeting** is described in an American patent taken out by Eastman Kodak Co., U.S. patent No. 2,084,313. A small percentage of calcium carbonate, 0.25-0.30 per cent., is incorporated in cellulose ester sheets (prepared by evaporation processes and not by regeneration). The amount of calcium carbonate is sufficient to roughen the surfaces of the sheets without affecting their transparency. This treatment is claimed to prevent adhesion between the sheets when they are stacked and to facilitate their subsequent processing in automatic packing machinery. **Resin-finishing treatments** of textile materials are mentioned by Röhm and Haas Co. in British patent No. 512,187. The materials, both yarns and fabrics, are treated with an aqueous emulsion containing 1-5 per cent. of a urea-formaldehyde resin, which is water insoluble but soluble in organic solvents, dried at 115-138 degrees C. and heated to harden the resin. The resin is preferably a condensate prepared in presence of a water-insoluble monohydric alcohol and may be plasticized with a castor-oil-modified glycerol-sebacic-acid resin. Production of non-shrink, non-slip, weighted, glazed chintz, delustred and other finishes is described.



CHEMICAL

Extracting pure cellulose is described in a recent U.S. patent. Process is reported to consist in treating the wood with a water solution of a monohydroxy alcohol. The alcohol, it is said, should have at least four carbon atoms and at least three of them in a straight chain; should be substantially insoluble in water at normal temperatures, but soluble at temperatures between 100 degrees and 200 degrees C. In addition to the alcohol, an inorganic alkali is used in amounts ranging from 2 to 10 per cent. The process, it is said, serves to dissolve in the water practically all of the non-cellulosic constituents of the wood, allowing the cellulosic constituents to

TRMPLOYS PLASTICS

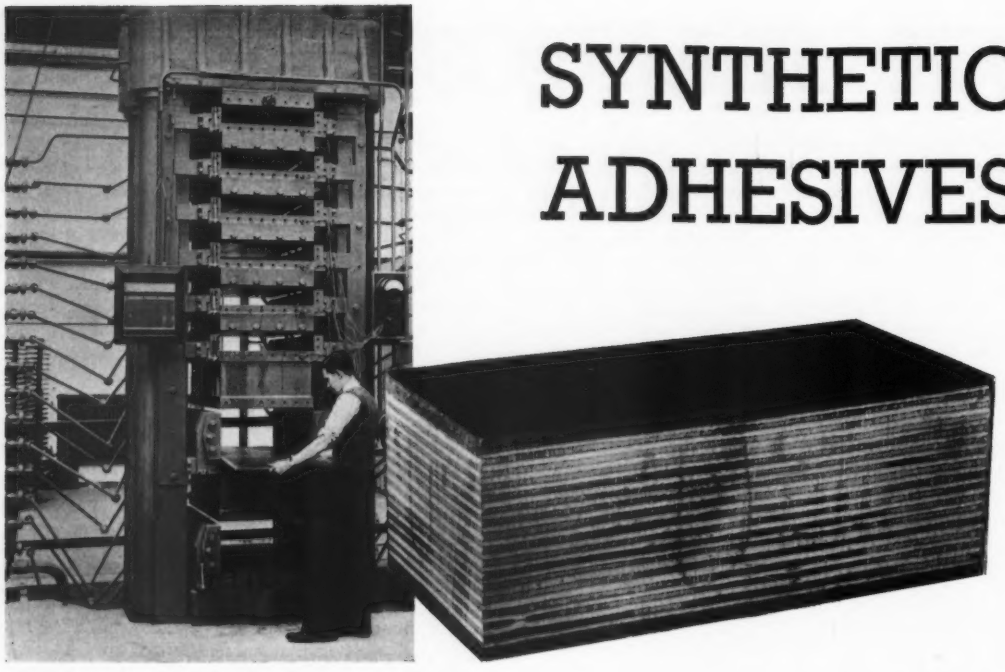
be separated out after a cooling process. **Filter fabrics** are now being made from the new synthetic fibre Vinyon, which is non-inflammable, resistant to mineral acids and alkalis and mildew-proof. Wellington Sears Co., New York, U.S.A., which is putting this new filter fabric on the market, announces that for over a year and a half it has been conducting a series of experiments with fabrics made from Vinyon fibre, ranging in weight from light balloon cloth up to heavier ducks, and in plain, twill and chain-weave construction.

MISCELLANEOUS

Hot-spraying of shellac is described in London Shellac Res. Bur. Bull. 5, Oct., 1939, 21 pp. Apparatus is described in which powdered lac is sprayed through a gas flame at a steady velocity which ensures fusion without ignition. Data show effects of varying the operating conditions. The coatings can be applied on various materials and were 0.1 mm. thick and slightly uneven. Suggested applications are for laminated insulation, containers for edible and crude oil, etc. **Lignin moulding compounds** are described in a recent U.S. patent, No. 2,080,078. Lignocellulose material, such as pine wood, is steamed under a pressure of 300 to 1,000 lb./sq. in. at a temperature of 210-285 degrees C., sufficient to modify the greater part of the fibre structure and obtain the requisite flowability for moulding, sufficient fibre being left unchanged to permit subsequent felting into sheets. The product, which may be explosively disintegrated by discharging through a constricted orifice and washed with water, forms a dense, water-resistant material when moulded for 10 minutes at 2,000 lb./sq. in. and 175 degrees C. The mouldable composition may also be felted from water into sheets, dried to 1-11 per cent. water content and a number of sheets moulded together to form a laminated product. **Polish-like coatings on metal** described in a new British patent, No. 513,517. The surface of the metal, e.g., iron plate, is cleaned and a combination lacquer of nitrocellulose and artificial resin, e.g., Rezyl, applied and allowed to dry. An absorbent layer, e.g., a sheet of wood veneer or paper, is then laid on the surface and the sheet coated with a film of thermoplastic material, e.g., cellulose acetate, and the whole consolidated in a press at 90 degrees C. and 30 kg./sq. cm. pressure. **Preparation of metallized cellulose acetate** mentioned in American patent No. 2,081,985. Sheets of cellulose acetate or similar material are impregnated with silver-nitrate solution and, after application as wrappers to bottle necks, are subjected to hydrogen-sulphide gas to form a silver-sulphide film or deposit on the surface of the material, which has then a metallic lustre. **Moisture-proof film** described in American patent taken out by Du Pont, No. 2,085,816. In moisture-proofing cellulose and similar film with a cellulose derivative, such as cellulose nitrate, together with a wax, plasticizer and binder, the composition is improved by using as a binder a hydrogenated rosin or rosin derivative, such as hydrogenated abietic acid. **Printing ink for artificial foils,** films and similar products is described in a recent U.S. patent. The ink is reported to consist of a pigment, an organic derivative of cellulose, such as cellulose acetate, and a plasticizer, used in a proportion at least five times as great as the total weight of the plasticizable material, suitably with the use of carbon black, iron oxide, benzyl alcohol, acetone, benzene and alcohol. **New acetate package** consisting of an inner flexible container fixed in metal pack is used in a new type of container designed to preserve the flavour of foodstuffs, such as coffee, sauerkraut. Package is made with an inner container, in which is inserted a pellet of solid carbon dioxide, dry ice. Outer container, says inventor, is capable of supporting the walls of the inner flexible container when pressure is exerted by the vaporization of the pellet.

Tensolite, which might be called processed Pliofilm, is the development of Henry D. Minich, consulting engineer of Philipse - Manor - on - Hudson, New York. According to *The India-Rubber Age*, Feb. 17, 1940, the "tensilization" of rubber hydrochloride seems to offer endless potentialities where neither rubber nor rubber hydrochloride could be used before the process was developed. The ultra-thin single-ply material, for instance, lends itself to packaging decoration and display, to various sanitary goods, hospital sheeting, fruit wraps, stage effects, sheeting for floral use and others. The laminated material, due to its range of thickness, colour, surface texture, strength and toughness, as well as to its resistance to water, oils, alkalis, alcohol, etc., may be used for a greater variety of purposes, such as adhesive tape, artificial flowers, bags, bag linings, bathing caps, belts, book covers, costumes, envelope linings, package ties, raincoats, ribbons, shower curtains, sweat bands, table covers, ticker tape, tobacco pouches, wall coverings and wind breakers. Threads and cords made from "tensilized" rubber hydrochloride are divided by Mr. Minich into three separate categories:—(a) Fine filaments for stockings, hairnets, braided fishing lines, filter cloth, weaving applications, tassels. (b) Threads for sewing, weaving, sutures, dental floss, decorative windings for sporting goods, braiding and a special form, called Pliolastic, for shirring and elastic cloth and braids. (c) Cord for musical strings, tennis strings, nets, cables, shock cords, macramé material, basketry material, chair seats, leashes, lacings and flexible tubes. The material for tennis and badminton strings Mr. Minich calls "Guttarubba." He gives the name "Florafilm" to that used for making artificial flowers, including the stamens. Yarns made of Tensolite, according to the inventor, may be made in numerous variations, such as crushed, twisted, rolled, multicolour, etc., which may be used for weaving mats, runners, upholstery, lamp shades and rugs; for braiding belts, berets, hats, shoes, bags, ties, suspenders, garters and decorative cords; for crocheting bags, sweaters, snoods, etc. Some excellent weaving is said to have been done with the material by the famous St. Mary's Weavers. Shaped articles, too, can be made of "tensilized" rubber hydrochloride, including inflated items, gloves, finger cots, bottle caps and covers, artificial flowers, pot covers, etc. The "stretch-wrap" process, using the machine specially designed for the purpose by Stokes and Smith, is said to enlarge this field, particularly when several plies are to be used to give desired strength, especially in the packaging of irregularly shaped articles, or where complete exclusion or confining is desired for moisture, odour, flavour, or other element. Other uses for Tensolite include the production of endless belts, particularly for light mechanical drives. The belts may be shrunk with heat to exact sizes and tension. Bristles in a wide range of thickness and stiffness, and, of course, colour, can be used for toilet brushes of various kinds, including tooth brushes. For buffing purposes, bristles may be made with or without an abrasive. Buffing brushes so made can be used to buff metals in acid and will withstand the action of other deteriorating materials. It is claimed that these applications by no means exhaust the industrial possibilities of Tensolite.

SYNTHETIC ADHESIVES



THE art of gluing goes back to the dawn of history and glue is one of the earliest products of primitive industry. In spite of its antiquity, however, very little was known about the actual mechanism of adhesion until the Great War of 1914-1918, when the Adhesive Research Committee first grappled with the problem as being one of increasing national importance. Their conclusions were rather startling, as they tended to discount the generally accepted theory that adhesion was due to a mere mechanical interlocking and instead attributed it to a specific force or attraction between the adhesive and the surface to be joined together. Later research by many independent scientists has advanced our knowledge very considerably and the theory is generally accepted that the specific force or attraction between the adhesive and the adherend is largely determined and governed by the character of the molecule. Each molecule can, by reason of its peculiar structure, exercise certain definite forces which might be compared with the forces of magnetism. It is these forces that are responsible for cohesion in solids and for the phenomena of surface tension at the boundaries of liquids.

Most substances can be divided into two main groups from the physico-chemical point of view, i.e. (1) those whose molecules have strong electrical stresses across them like water, alcohol and wood—these are called polar substances; (2) those whose molecules do not set up electrical stresses across the molecule and are exemplified by benzene, paraffin oils and metal. There are, of course, an enormous number of intermediate compounds, for example, acetic acid, stearic acid, etc., which contain both polar and non-polar groups, their final behaviour depending on the supremacy one group may have over the other. Like attracts like in nature and this rule also applies generally to glues. Thus, modern synthetic adhesives, which are strongly polar, are attracted by polar solids, such as wood. On the other hand, metal is non-polar and for this reason resin glues will not stick to it very readily. An exception to the general rule is fish or hide glue, which is a mixture of complex proteins able to undergo chemical changes under varying conditions. They are not, in fact, pure adhesives and thus display dual polarity. Dr. de Bruyne, who has done a great deal of work on synthetic adhesives, says that, provided we use pure or simple substances as adhesives, there is a good deal of evidence that strong joints can never be made to polar adherends with non-polar adhesives and to non-polar adherends with polar adhesives.

Although wood is a polar material, treated wood is non-polar, due to loss of water on heating and also to actual changes in the structure of the molecules, and cannot easily be stuck with polar glues, such as urea-formaldehyde or phenol-formaldehyde resins. This explanation certainly helps to account for the fact that occasionally aircraft and furniture manufacturers come across plywood that will not stick with a synthetic-resin glue owing, probably, to the fact that the sticking surface of the plywood has been overheated during manufacture and thereby changed from a polar to a non-polar material, similar to metal, or Bakelite. The same argument applies with equal force to compressed laminated wood which cannot be glued with synthetic-resin adhesives.

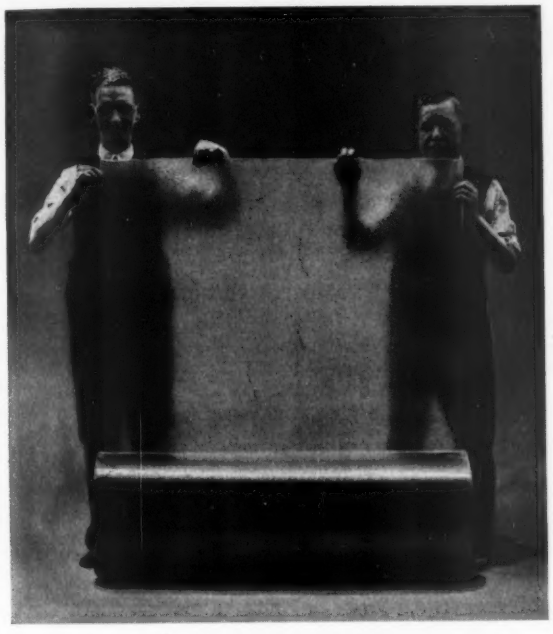
Whilst the polar theory does account for a good deal, it is by no means a complete explanation, as adhesion may, to some degree, be interpreted by means of the mechanical theory. Prof. McBain held that adhesion to wood is mechanical rather than specific. Mechanical adhesion in "pores" that are too small to be seen in a microscope should, however, properly be called ultra-microscopic mechanical adhesion and must be clearly distinguished from the layman's conception of mechanical adhesion, such as the sticking of plaster to laths where a definite key is formed. It has been said that mechanical adhesion between two solids is possible without the use of an adhesive, provided perfect contact is made between the surfaces, but as the range of action of the surface forces is of the order of 3×10^{-8} centimetre the surfaces must match exactly, and even the most highly polished surfaces are far too rough and uneven to meet these requirements.

Synthetic adhesives have now become of very great

importance in a number of widely different industries, particularly in aeronautical construction, furniture manufacture, the footwear industry and dozens of other fields of industrial activity. They all have important advantages over the natural products because of their greater durability and strength under bad conditions of service, such as in the presence of heat and humidity, and they are also completely immune to the effects of bacteria and fungi, which are always liable to attack skin, fish and casein glues, etc. A general survey of synthetic adhesives is given and includes all the best-known materials likely to be of interest either at the present time or in the future.

Phenol-formaldehyde Glues

Although alcoholic solutions of phenolic resins are extensively employed for impregnating purposes, they are also used as adhesives pure and simple. The development of dry gluefilms made by impregnating tissue paper with a solvent solution of phenol-



A roll of Tego dry gluefilm.

formaldehyde resin has, however, focused attention on the advantages of a dry glue, as compared with a solution. Dry gluefilms are extensively used in furniture manufacture, aircraft construction, cabinet making, building construction, panelling, shipbuilding, sectional building, rolling-stock construction, etc. The gluefilm is made in a continuous sheet supplied in rolls and is applied under heat and pressure by the hot-bonding process. Two different dry gluefilms are made in this country: Plybond, manufactured by Bakelite, Ltd., and Tegofilm, produced by British Tego Gluefilm, Ltd. The main advantages claimed for these adhesives are that they afford a bond of maximum strength between wood surfaces that is waterproof and weather-proof, repellent to mould, mildew and fungi and resistant even to boiling water. Simplicity of handling and working with the dry phenolic gluefilm contributes a great deal to its growing popularity. The advantages of this versatile adhesive may be briefly summarized as follow:—

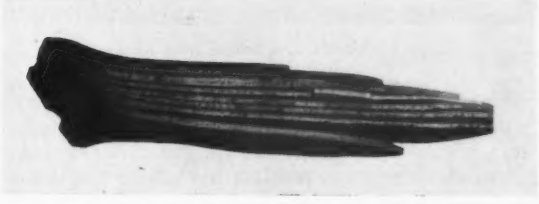
1. Dispenses with the use of liquid glues and does away with the necessity to spread the glue over the wood surface. All that is required is to place a sheet of the dry adhesive between the two pieces of wood to be glued and apply the necessary heat and pressure for bonding. This results in a considerable saving of material, time and money.

2. There is no deterioration of the glue, as with casein, and all pieces of the dry gluefilm left over from an operation can be retained for further use.

3. Use of the dry gluefilm standardizes plywood construction and ensures uniform production.

4. The bond formed by the adhesive is highly resistant to moisture, bacteria and fungi.

5. The bonded wood is remarkably free from any tendency to warp, twist and split, and it is claimed that dimensional stability is far greater than is the case with all casein-glued plywood. This is due to the fact that with dry gluefilm there is a complete absence of any glue water, and it is, therefore, unnecessary to engage in expensive re-drying methods, through which variable and uncontrollable internal stresses may be set up, with their tendency to produce warping, twisting and incipient cleavage in plywood.



Propeller in the rough built of laminations of improved wood.

One of the most interesting applications of the dry gluefilm is in the manufacture of compressed wood, sometimes known as improved wood. This consists of a large number of thin veneers bonded together by means of leaves or sheets of the glue. Tegofilm has been extensively employed for this purpose and produces a hard, tough, impervious laminated material of high strength-weight ratio which finds important applications for aircraft propellers, aircraft spars, gearwheels, rifle and gun stocks, casters, weavers' shuttles and dies for shaping light metals, etc.

The durability of wood bonded with dry gluefilm is exceedingly high and all tests show that the greatest strength is at the glue-line. Tego-bonded panels have, for instance, been immersed in water and buried underground for a period of years without any damage to the glue-line.

The advent of dry gluefilm bonded plywood has led not only to its wider use in the usual spheres, but to the development of entirely new applications. Hence its value in aeroplane construction, for boats, surfboards and canoes, for bodies of vans and vehicles and for woodwork in factories and works. It is valuable, too, for signboards, hoardings, showcases, portable sheds, etc., on account of its weather resisting qualities, and the Americans regularly use Tego-bonded panels in the construction of standardized wooden houses. For all these purposes, and many others, it proves satisfactory.

Special Phenolic Cements

These find important applications in the chemical and allied industry for setting and pointing acid-resisting bricks, tiles, linings, etc., also for applications where a non-porous corrosion-proof cement is required. The

best known produced in this country is Keement, manufactured on a phenol resin base with a special filler by Kestner Evaporator and Engineering Co., Ltd.

It is simplicity itself in use and is applied by mixing with an accelerator. Self hardening of the cement takes place at ordinary temperatures within a few hours; no heat treatment or stoving is required. When set, the

Large brick-built tank sealed with Keement.

cement is hard, acid resistant and forms a very dense mixture. Very narrow joints can be constructed in tanks, so that the factor of safety is materially increased. When set, Keement is resistant to extreme temperature changes and will not crack by freezing or boiling acids. It does not soften by age or by temperature, and all that may be necessary is occasional repointing after some years. It is possible by varying the filler to produce Keement of various grades for special applications.

Urea-formaldehyde Glues

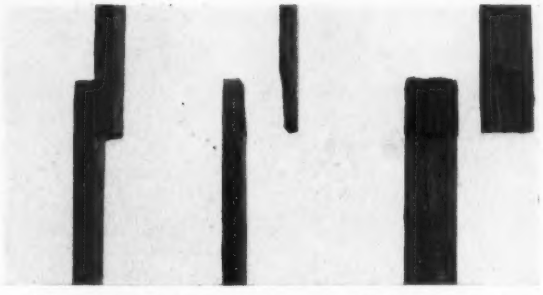
These differ in several ways from the standard dry film synthetic glues and probably the most obvious is that, unlike single ready-to-use adhesives, such as Tegofilm and Plybond, urea adhesives consist of two compounds, the glue and a hardener which have to be mixed together immediately before use.

Like the dry film glues, the urea adhesives find their most important applications in the aircraft industries, where they help to simplify production by increasing the speed of jointing wood and ensuring the maximum strength of jointed parts. Dr. de Bruyne gives the following advantages of these synthetic glues:—

1. Great increase in speed of production of work.
2. Great reliability of a product made synthetically under carefully controlled conditions.
3. Small water content ensuring freedom from distortion in the completed structure.
4. Absolute immunity to attack by mould or fungus.
5. Increased water resistance.
6. Increased strength.

Various types of hardener are supplied by the manufacturers according to requirements, that is, whether a slow or quick setting glue is needed or whether the hot or cold process of gluing is to be adopted.

There are two different makes of urea glues in Great Britain—Aerolite, manufactured by Aero Research, Ltd., and Kaurit, produced by British Industrial Plastics, Ltd. The first named is a liquid containing a very small percentage of water. Before use a hardener is added and the mixture is then ready for immediate use. The mixed glue is applied to one of the surfaces to be joined with a brush or by means of a glue spreader. The surfaces are then clamped, screwed or bradded together in the usual way. A very moderate amount of heat is then applied by covering the component (which may, for instance, be the whole wing of an aeroplane) with an electric blanket. The speed of setting of the glue is quite unaffected by changes in humidity, but it is greatly affected by temperature. During use the glue should be kept as cool as possible; after application some heat, even only a moderate rise in temperature, is necessary. The glued joint, when tested to destruction, always shows a wood failure. With compressed wood, figures in excess of 2,000 lb. per sq. in. are obtained, when tested according to Spec.4V3.



The results of a test carried out with Aerolite glued wood. Note way the wood has broken.

For plywood and veneers these urea glues are particularly useful and Dr. de Bruyne recommends mixing the urea glue, in this case Aerolite, with rye flour and water in equal proportions. Thus, a mixture made of 100 parts Aerolite glue, 100 parts water and 100 parts flour will give extremely economical results and, though the waterproof qualities are somewhat reduced, the water resistance is still good and surpasses that of a good class casein. The advantages of this type of synthetic resin adhesive for this particular kind of work can be summarized as follow:—

1. It cannot stain the most delicate veneers.
2. It will not cause blistering or pimples.
3. There is a considerable increase in strength over normal glues.
4. It is simple to prepare and can be used immediately after mixing.
5. It sets quickly and certainly without the use of excessive temperatures or pressures.
6. Mixing of the glue and its application is done in the cold spreaders.
7. It is unnecessary to cool platens.
8. The glue does not affect tools.

The manufacturers of Kaurit glue, which is also a liquid product similar in many ways to Aerolite, stress the fact that only the minimum amount of moisture is required to render the glue ready for use, 1 to 1½ lb. per 100 sq. ft., whereas in ordinary cold glues about 6 lb. of water are applied to each 100 sq. ft. Evaporation of the moisture is also a good deal faster with urea glues, as the water is not held in a glue jelly as is the case with casein and skin glue. Low moisture content of the adhesive is important as it not only increases speed of jointing, but also prevents warping and distortion during the drying out of the moisture.

The fact that different types of hardener are available to suit varying conditions of gluing or to meet

special requirements is considered by many practical men in the woodworking industry to be an advantage as it renders the glue more adaptable. New hardeners are regularly being produced to give special results in service. Thus Aero Research, Ltd., has after prolonged investigations, brought out a special hardener which enables good joints to be made between badly fitting surfaces where there may be as much as a 20/1000-in. gap between the two members. The resultant joints possess shear strengths above Air Ministry requirements.

Casein Glues

These excellent adhesives have been known to craftsmen for thousands of years and, according to one report, the craftsmen of ancient Egypt, Greece, Rome and China used casein glue in their finest cabinet work. To-day casein glues are extensively employed in plywood manufacture and also for sticking laminated plastic veneers to plywood bases. They are particularly valued because they are cheap and plentiful and the casein joint is reasonably water resistant.

According to Sutermeister and Browne, "Casein and its Industrial Applications," casein glues may be classified as (a) prepared glues, (b) wet-mix glues. Prepared glues are sold in the form of dry powders containing all necessary ingredients, except water. The user adds the powder to water at room temperature in the proper proportions, usually about two parts of water to one of glue by weight, employing a mechanical mixer. Most of them can be mixed ready for application even in large batches in less than 30 minutes. Once mixed, the glue must generally be used within a working day or less. Some casein glues used in fields other than woodworking must be warmed to bring them into solution and they may not be subject to the restriction of use within the working day.

Wet-mix glues are made as required for use from ground casein, water and the additional chemicals called for by the formula.

Both prepared and wet-mix glues are used by the woodworking industries in large quantities. Each type has advantages. Wet-mix glues permit the use of desirable ingredients that cannot very successfully be incorporated in prepared glues. With wet-mix glues the formula can be varied at will to meet special requirements and in general a smaller proportion of alkali can be used in making the glue. Possibly the most important reason for the wide use of wet-mix glues is the fact that the formulas commonly used require the addition of slightly more water per pound of dry ingredient and involve very inexpensive materials, so that the cost per square foot of glue-line may be less than that of prepared casein glues.

Rubber Adhesives

These find many important uses, particularly in the footwear industry. Rubber dissolved in suitable solvent will make a cement possessing reasonable adhesive properties, but most commercial rubber cements are not as simple as this and usually contain various additives able to decrease the viscosity and increase their sticking qualities and durability. Rubber cements may be applied to paper, felt, leather, metal, glass, wood, marble, alabaster, plastics and other materials and will adhere to varnishes, lacquers and enamels without injury to the surface.

A solution of crepe rubber in benzene will make a cement of sorts, but the commercial cements are much more complicated than this and may contain as many as seven or eight different ingredients. There are three different types on the market; non-vulcanizing, self-vulcanizing and hot-vulcanizing. The first named usually contains a small proportion of ester gum and mixed solvents, such as benzene and dichlorethylene. Self-vulcanizing cements generally contain sulphur-chloride in carbon disulphide and small proportions of accelerators. Hot-vulcanizing cements make use of sulphur which is mixed with the rubber before the application of heat. Latex cements are also widely used, the best known non-vulcanizing type being a mixture of starch adhesive with a 40 per cent. latex dispersion.

Mr. W. N. Lister, A.M.C.T., A.I.R.I.(Sc.), in a paper dealing with textile rubber composites, solvents and cements, published in the "Annual Report on the Progress of Rubber Technology," Vol. I, 1937, mentions a new series of adhesives called marbonized rubber adhesives, which, it is claimed, produce a permanent bond over a wide range of temperatures and adhere to any surface and can be brush applied. These may be (1) exceedingly tacky or (2) tacky for a few days or (3) cold setting with resistance to acids, alkalis and salts, or transparent and tacky, suitable for transparent adhesive tape, or (4) of a special type with high dielectric properties. A suggested composition consists of an aqueous disperson of rubber 40 to 75 per cent.; glycerine 15 to 40 per cent.; casein 3 to 8 per cent.; and added water of the order of 20 per cent. of the total ingredients.

The best-known proprietary rubber-base adhesives are the Bostik industrial adhesives made by B.B. Chemical Co., Ltd., Ulverscroft Road, Leicester. The following is the general classification of these compounds:—

Grades 1-49. Protected latex and paste type cements which are non-inflammable.

Grades 101-149. Pyroxylin cements.

Grades 151-199. Solvent rubber solutions.

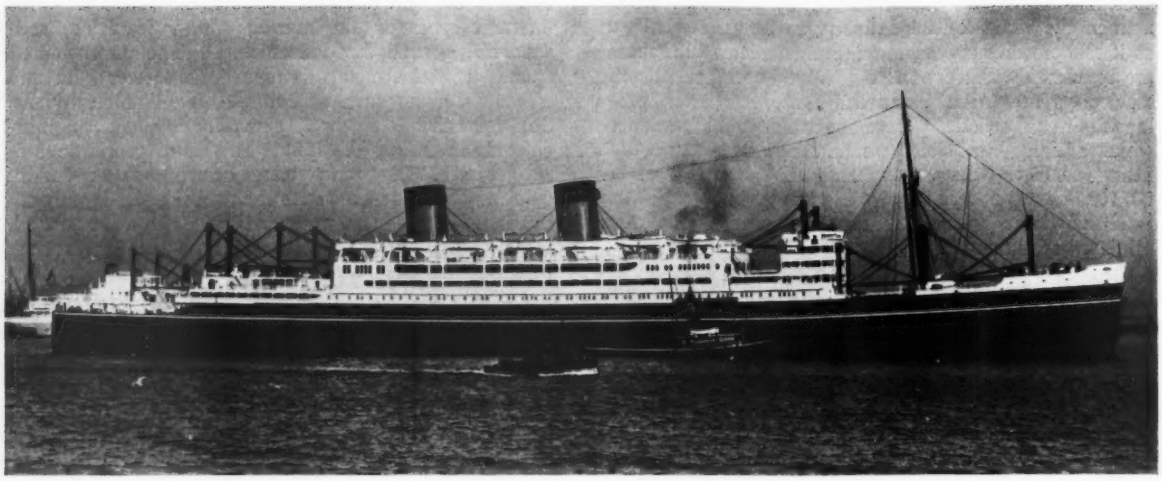
Grades 251-299. Black rubber cements of high viscosity.

Grades 301-349. White or grey rubber cements of medium viscosity.

All these cements give very strong adhesion, are water-resisting and resilient. They adhere to almost every surface and may be used with success for attaching rubber, felt, canvas, linoleum, fabrics to wood, concrete, metals and synthetic materials such as Bakelite, Perspex glass, etc. They are used extensively in a variety of different trades, particularly in motorcar and omnibus building industries, building, shipbuilding, aircraft, footwear, etc. At the present time a considerable quantity of Bostik glazing compound is used for sealing purposes in aircraft construction. A bead of the cement is flowed from the tube all round the flange of the frame and while the bead is still soft the windows or screens are pressed into it. A further small bead is flowed round the inside of the windows or screens and the inside fillet plates are immediately screwed into position. The adhesion of this rubber base cement is sufficient to withstand any pressure or stress and strain to which these windows are likely to be subjected in the course of flight and this film will allow for the expansion or contraction of the window without the actual film of cement breaking.

Characteristic features of these cements are that they are waterproof and watertight. They never set really hard, but always retain a certain degree of resilience, although the adhesion obtained is exceptionally strong.

This article will be continued in our next issue. The next instalment will deal with cellulose, acrylic and vinyl adhesives.



Plastics in Modern Shipbuilding

IN a paper entitled "The Chemist and the Ship," collated by J. E. Holmstrom, B.Sc., Ph.D., Assoc.M.Inst.C.E., and published in "The Transactions of the Institute of Marine Engineers," Vol. LI, No. 12, a section dealing with the applications of plastics is of particular interest. The contributor of this section, Mr. F. Heywood, stresses the fact that plastics have many properties which commend them for ships' use, notably freedom from rusting or corrosion, good electrical properties, low weight and attractive appearance. Almost all plastics share these properties, whilst many are, in addition, non-inflammable or have a low degree of inflammability. Each possesses characteristics which render it suitable for specialized applications; thus, the synthetic resin methyl methacrylate is distinguished by its optical clarity exceeding that of the best glass, whereas the flexible vinyl resins are chiefly of interest because they combine many of the useful characteristics of rubber with the additional valuable properties of non-inflammability and resistance to ageing influences and to oils.

Plastics have, as yet, not entered into the main structure of ships and it is unlikely that the materials at present available will do so. The principal reason is that, although certain of the plastics are actually stronger on a weight basis than the established structural materials, their cost at present so far exceeds that of structural steel and wood as to render this circumstance relatively unimportant. A further consideration, states Mr. Heywood, is that plastics cannot normally be fabricated with the same facility as steel and wood and usually require a high pressure moulding technique at some stage in their production or fabrication, the size of the units being consequently limited to that of the press equipment available. For these and other reasons plastics can be usefully considered only for internal structure and decoration and for auxiliary equipment.

The use of dry film phenolic glue is rapidly growing, as the bonded plywood or panels are unaffected by temperature and humidity variations or by long immersion in water, and the glue itself is immune from attack by moulds. Gaboon plywood bonded with synthetic resin glues of this type is now being used extensively for bulkheading, where the large unbroken surface is of advantage from the point of view of strength, consequent weight reduction and the saving in erection cost. Moreover, the fire hazard is reduced by reason of the smaller volume of wood required as compared with tongued and grooved boarding and of the lower inflammability of plywood. The use of urea-formaldehyde resin glue for fine veneering is rapidly extending. It is particularly suitable for this purpose as, in addition to providing a water and mould resistant bond, it does not cause staining of the veneers.

The urea-formaldehyde and phenol-formaldehyde resins find another important application in the production of decorative laminated materials which have been used successfully for the panelling of public saloons, barbers' saloons, bathrooms and cocktail bars. These laminated veneers are usually cemented to a backing of plywood, asbestos, fibreboard, etc. Another well-established use for laminated materials is for signs, identification plates and labels where the non-chipping, non-discolouring properties are of value.

The use of moulded accessories and fittings is so well known that there is little need to make more than passing reference to them. Telephones, door furniture, toilet seats, ashtrays, Thermos jugs, desk lamps, switch plates, lamp brackets, lamp shades, coat hooks and wash-basin accessories, such as soap rack, water jug and towel rail, are some of the items for which plastics are accepted materials. The earliest experience with some of these fittings was not always successful, a fact which emphasized the importance of selecting a plastic for its specific purpose with the same care as a metal would be chosen for a machine part. The characteristics of the various plastics are now so well known that when the operating conditions are also known no difficulty need be experienced in choosing the right material.

The clear, transparent plastics, of which methyl methacrylate is a notable example, have for some time been extensively used in preference to glass in air and land transport and there is little doubt that they will receive increasing attention from naval architects. The extreme clarity of these materials, coupled with the ease with which they can be shaped when heated, high impact strength and flexibility, render them of interest for internal decoration and lighting schemes, as well as

for other uses, such as meter dials and glasses and instruments in the chartroom. Developments along these lines are, in fact, already taking place. Lightweight binoculars provide another example.

Mr. Heywood refers to the use of laminated bearings in industrial plant, but makes no mention of their use as ship engine bearings. He mentions, however, that rubber bearings are already being used successfully in small craft and their high resistance to abrasion makes them especially valuable for use in coastal waters, where a large amount of grit and sand is encountered; under such conditions a life of four times as long as that of metallic bearings has frequently been attained. There appears to be scope, also, for some of the laminated plastics and for resin impregnated wood for tail shaft bearings and thrust blocks in place of lignum vitæ and for bushes in auxiliary gear, where water lubrication can be arranged.

Dealing with the electrical applications of plastics in modern ship fitting, the author is of the opinion that they are likely to find increasing use in electrical distribution systems for lighting, power, heating and cooking in ships. Here a range of conditions has to be met which includes high humidity, wide temperature variations, vibration and exposure to fuel and lubricating oils. Meter cases, switch and fuse housings, bushings, lighting fittings and other parts should be moulded in high resin content moulding materials which have very low water absorption and, as in the case of some materials, it is advisable, as an additional precaution, to paint the surfaces of mouldings with a high grade of non-tracking varnish to guard against a type of breakdown liable to occur in moist atmospheres, especially where salt carried over by spray may also be present. The urea-formaldehyde moulding materials are much less liable to the tracking type of breakdown and, as they are available in white and in light and dark colours, they are particularly suitable for marine electrical parts.

It is anticipated that some of the plastics based on vinyl chloride, as well as the synthetic rubbers, will, before long, be employed for the sheathing and insulation of low voltage flexible cables for ships' use. The attraction of these materials lies in their relative non-inflammability, non-ageing properties, marked resistance to lubricating oils and, in the case of some of them, the fact that they can be made in a very wide range of colours, which is of importance in multi-core cables.

A small, but important, use for plastics is in connection with low-power loss dielectrics, such as are required in radio reception and transmission apparatus. Polythene and polystyrene are two of the newer plastics which are worthy of note for applications of this type.

Design of Plastic Heel is Improved

SEVERAL new developments in construction technique have been revealed by the Pearson Heel Mfg. Co. of St. Louis, U.S.A., whose first step into the plastics field was announced a year ago with a composition heel made of cellulose acetate.

The original design for nail-seatings consisted of a horseshoe-shaped line of holes just inside the upper heel rim and numbering between 15 and 20 holes, depending on the size of heel. A great many difficulties were encountered in machine-fastening the nails with this shape of nail-hole outline, chief among which was that of the nail bending when the machine failed to coincide accurately with the holes. This condition was not serious so long as the nail was struck within a $\frac{1}{16}$ in. or less of the hole, since such a variation would automatically cause the nail to seat. But with only five nails being used on the horseshoe pattern the percentage of misstrikes considerably slowed up production and raised materials cost.

The condition was finally remedied by redesigning the heel structure, incorporating into the mould a device which produces a honeycomb arrangement in the nail-seating holes. None of these holes is farther apart than the distance required to cause an automatic seating in case of a machine misstrike. Nail holes are set in varying lengths, also, in the transparent heel, giving the honeycomb pattern an additional eye appeal for fancy styling. An unusual feature of the new plastic is that it renders nails self-fixing, which factor, now that the misstriking element is removed, insures the permanency with which the heels are attached to the shoes.

Two additional changes have been developed in the process of mounting the plastic heels to conventional footwear, both of which, it is claimed, will result in decreased costs to the manufacturer. One is the cutting of a wide cavity in the front portion of the heel, thereby reducing the quantity of plastic needed for each heel. Since this cavity does not impinge upon the heel's strength, but rather adds resilience, it is a two-fold advantage, for, since the material's cost is estimated by the weight, the cost to the manufacturer is reduced.

The other alteration is in the process of attaching the sole to the heel. Instead of using a sole leather the full length of the shoe, turning it at the point where the heel joins the shoe and attaching the remaining length to the front side of the heel, as in conventional designs, the heel is being made with a narrow horizontal slot at its upper front end, into which the end of the sole fits. The elimination of the extreme end of sole leather which normally is attached to the heel's front side is expected to result in a considerable saving to shoemakers. It is said that this change in sole dimensions will, in many cases, permit the reclamation of a great quantity of odd-shaped sole leather stock, of dimensions adaptable to the cutting of short soles but which would not be large enough from which to cut ful soles. Emphasis is placed upon perfect matching of grains and shades of leather by the plastic heels.

Close-up of the moulded acetate heel.

The medical profession has examined and approved the use of methyl methacrylate resin as a material for denture bases.

ACRYLIC RESIN DENTURES

The claims of acrylic resin to be used for denture bases are carefully examined in this article by W. T. Sweeney, published in the February issue of "Modern Plastics." The original paper was read before the Full Denture Prosthetic Section of the American Dental Assoc., July 19, 1939

AN investigation of the physical properties of acrylic resins used as denture base materials was undertaken by the American Dental Association Research Fellowship at the National Bureau of Standards during the past year. An initial study of the properties of the various plastics indicated that methyl methacrylate resin should be satisfactory for a denture base. Methyl methacrylate resin compares favourably in strength, density, moulding characteristics and toughness with hard rubber, which has been the most used and probably the most satisfactory denture base material from both the standpoint of mechanical properties and clinical experience. It is the purpose of this paper to show how methyl methacrylate resin compares with denture base rubber and other materials used for denture construction. Tests were made on shelf life, curing, colour stability, dimensional change and such mechanical properties as strength and hardness.

In order to determine the amount of time that the dentist may safely store units of acrylic resins, a series of tests on shelf life were carried out in which specimens of resin were stored at 5 degrees C., room temperature (approximately 25 degrees C.), 37 degrees C. and 43 degrees C., after which their mouldability was determined. These temperatures were chosen as representative of temperature ranges encountered in shipping or in dental offices. Observations were made at various intervals of time, namely, 4, 8, 11, 15 and 45 days and 2½ months. After each of these intervals of time the specimens of resin No. 3 were packed in denture flasks to determine whether they were still sufficiently plastic to be adapted to the mould. The progress of the storage cure was very slow at the lower temperatures and very fast at the higher temperatures, with the result that this material was considered satisfactory for use after storing, as follows:—

(1) For at least 2½ months at 5 degrees C. (41 degrees F.).

(2) For 15 days at room temperature (approximately 25 degrees C. (77 degrees F.)).

(3) For one week at 37 degrees C. (99 degrees F.).

(4) For one day at 43 degrees C. (109 degrees F.).

The specimens used in this series of tests were sealed in glass containers in order to prevent evaporation and the rapid cure which takes place in the presence of oxygen. It was observed that specimens left in the atmosphere cured much faster than those stored in sealed containers. Therefore units should be stored in the dark and in a closed container at the temperature ordinarily obtained in a household refrigerator, since oxygen, ultra-violet light and heat are known to promote the polymerization of this resin.

Acrylic resin No. 1, which is furnished in the form of a powder and a liquid, showed no apparent change in working qualities when stored at laboratory temperatures (25 ± 5 degrees C.) for more than a year. This is probably because of the presence of an inhibitor added to prevent polymerization at lower temperatures. The powder and liquid are mixed immediately before using and have a distinct advantage in shelf life over the materials furnished in cake form.

Curing.—One of the desirable features of these resins is the ease with which they can be packed and cured. The material furnished in the form of a plastic cake is packed similarly to rubber, that is, the cake is placed in a warm mould (approximately 77 degrees C. (170 degrees F.)) and the flask is closed in a compression clamp. The flask, after closing, is placed either in boiling water or in a vulcanizer for curing. The material will cure satisfactorily in 30 or more minutes at the temperature of boiling water. The plaster is easier to remove from the denture if it is cured

in a vulcanizer at 138 degrees to 149 degrees C. (280 degrees to 300 degrees F.) for 30 minutes or more.

Comparison of Mechanical Properties.—From a study of Table 1 a comparison of acrylic resins with olive base rubber and veneer rubber can be made. The transverse test data indicate that acrylic resins were not so stiff as a typical sample of olive base rubber. For example, acrylic resin No. 3 shows a deflection curve that closely approximates the olive base rubber, while the other two materials are somewhat more flexible. The maximum strengths of the acrylic resins are, in general, of the same magnitude, ranging from 6,100 to 8,000 gr., while the breaking loads for olive base and veneer rubber were 8,000 gr. and 6,800 gr. respectively. The tensile strength of the acrylic resins was higher than that of the rubbers. The indentation hardness numbers are of the same order as of other denture bases.

Table 1.—Mechanical Properties of Denture Base Materials.

Material	Transverse Tests at 37° C.			Tensile Strength at 25° C.
	Deflection of load of		Breaking Load	
	4,000 Grams	6,000 Grams		
	Mm.	Mm.	Grams	Kg./Cm.²
Acrylic resin, 1 ..	2.25	7.06	6,100	575
Acrylic resin, 2 ..	2.01	4.30	7,000	685
Acrylic resin, 3 ..	1.79	3.91	8,000	641
Olive base rubber ..	1.68	3.64	8,000	555
Veneer rubber ..	1.38	4.46	6,800	450

Table 2.—Indentation Hardness of Denture Bases (Knoop Method).

Material	Indentation Hardness
	Kg./Mm.²
Vinyl resin	13.0
Metal-filled base rubber	13.2
Olive base rubber	13.4
Veneer rubber	16.4
Acrylic resin No. 1	17.5
Acrylic resin No. 3	17.6
Acrylic resin No. 2	20.3
Phenol-formaldehyde resin	27.0

Table 3.—Curing Shrinkage of Denture Base Material.

Material	Linear Shrinkage per cent.
Acrylic resin, No. 1	Average ·47
Acrylic resin, No. 2	Average ·56
Acrylic resin, No. 3	Average ·55
Olive base rubber..	Average ·31
Maroon base rubber	·47

The above figures are averages for three determinations.

Observations on Dentures in Service.—In order to obtain some information on what changes are taking place in the material after the denture is placed in service, a few practical cases were constructed in co-operation with the Army Dental Corps, the University of Pittsburgh Dental School and the Georgetown University Dental School. Models of the bearing surface of each of the dentures were made after the case was ready for insertion in the mouth. Marks were placed on the dentures, on which observations with a microscope could be made for the determination of the dimensional changes. The models were stored at a constant relative humidity of 32 per cent. and were made from the same dental stone.

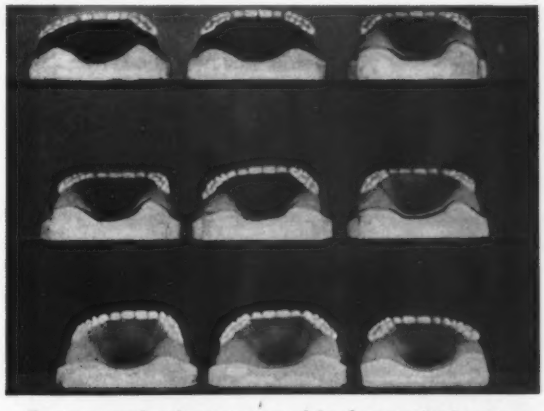
These dentures were examined from time to time by visual inspection and microscopic measurements to ascertain what changes in colour and shape, respectively, were taking place. The fit of the denture was judged by placing it on the model, and was considered satisfactory if there was no space visible between it and the bearing surface of the denture. While these observations cover only a few cases, which may not be representative samples of dentures in service, they do give some very interesting information.

The study of these dentures indicates that a dimensional change of more than 0.5 mm. occurred in one denture in the negative direction, while another showed a positive change of more than 0.25 mm. A full upper denture after one year's service would not go to place on its model by 1.5 mm. at the posterior palatal periphery. The patients in all of these cases said the dentures gave them satisfactory service and caused no discomfort in the mouth.

The number of cases is too few to draw any general conclusions, except that they indicate that the dentures, made of phenol-formaldehyde resins, were not colour-stable in service and that the acrylic acid resins were far superior in this respect.

Warpage of Dentures.—In order to study the change in fit of dentures when they are placed in service, nine similar full dentures were made from one master model. A stone model of the bearing surface was made of each denture after it was polished and finished. Of the nine dentures, two were rubber, three were phenol-formaldehyde resins, one was a cellulose compound and three were acrylic resins. All of the dentures were made of materials purchased in the open market and were processed by a commercial dental laboratory, according to the directions accompanying the respective materials. These dentures were then stored in water at approximately 37 degrees C. for 15 days and were replaced on their respective stone models. It is evident from a study of the photograph shown that some of the dentures so treated warped appreciably. In fact, some did not go to place on the model by as much as 1 to 2 mm. in the palatal area. The dentures made from rubber and acrylic resins showed less warpage than the phenol-formaldehyde resin dentures. Inasmuch as the first eight of these dentures were made up and treated identically and the ninth comparably, it seems quite significant that such a large variation in dimensional stability was observed. The effect of change in environment on warpage was also studied. Tests showed that the dried denture expanded when immersed in water and that the wetted denture shrank in air.

When all factors are considered, the acrylic resins appear to be the most satisfactory plastics currently used for denture bases.



Dentures replaced on stone models after storing in water 15 days. Accuracy of fit may be judged by noting space between denture and the model. Those on the bottom shelf are moulded of acrylic resin and show no gap between the stone and the denture base.

PRODUCTION

Practical Information dealing with Raw Materials, Moulding and Forming of all types of Plastics—Thermo-Hardening and Thermo-Plastic—Works-Organization, New Plant and Control Apparatus

NOTES AND COMMENTS

Fire at Acetate Warehouse

The fire which broke out at the warehouse of May and Baker, Ltd., of 42-43, St. Paul's Churchyard, London, E.C.4, on Wednesday, February 21, caused very severe damage and almost completely gutted the lower floors.

It is satisfactory, however, to learn that, as May and Baker, Ltd., have very large stocks in sub-depots conveniently situated in and around London, it is not expected that there will be any delay in meeting the requirements of their many customers in the aircraft and allied industries. For the time being, however, they are unable to deal promptly with small orders for the fancy goods trade, which entail unpacking and repacking. In view of the circumstances May and Baker, Ltd., ask their customers to make some allowance for any slight delay that might be experienced in executing orders. Good supplies of Rhodoid are arriving regularly from their works, and it is hoped that the inconvenience caused by the fire will be overcome in a week or two.

Incidentally, the way in which the stock of Rhodoid stood up to the fire was little short of amazing, as although the interior was for over an hour a blazing furnace, damage to the thinner material is largely due to water, while the greater part of the thicker material has remained in perfectly satisfactory condition.

The fire gave ample evidence of the non-inflammable nature of acetate sheet.

The wooden racks holding much of the stock were destroyed, but the Rhodoid stocked on the shelves is but slightly fused at the edges, and stands a convincing witness to its own non-inflammability.

Shellac Research

Our friend, Mr. A. J. Gibson, of the London Shellac Research Bureau, has forwarded us a copy of the annual report issued by the Polytechnic Institute of Brooklyn (Shellac Research Bureau). This useful little booklet is illuminating for the exposé it gives of the widespread research taking place throughout the world on the unique substance.

To our own industry the greatest interest lies in the attempts made to mould shellac into finished forms and the new methods of spraying it. Both methods have been worked in London. America, through the Insulation Manufacturing Co., has also done a considerable amount of work on moulding shellac for the production of very high-voltage insulators. Some very interesting results have already been obtained during a preliminary study of the effect of incorporating fillers.

Obituary

It is with deep regret that we record the death of Alderman Chas. E. Gardner, J.P., at the age of 73.

Mr. Gardner, who died on Saturday, February 17, after but a short illness, was known wherever the reduction, sifting and mixing of powdered materials were of interest.

He succeeded his father, who founded the business in 1859 with four workpeople, in the Chairmanship of Wm. Gardner and Sons (Gloucester), Ltd., the largest and probably the best-known firm in the field of powder production machinery.

Mr. Gardner's life was one of service to his fellow men both in his business and civic activities. The welfare of his workpeople and the control of a business which expanded rapidly under his direction, were his first concerns, and he was never happier than when celebrating some anniversary or stage in the progress of his firm in the midst of his employees.

Yet he found time to devote to the welfare of his native city, for he was an Alderman of the Council of the City of Gloucester and a Justice of the Peace for many years. He was Mayor of the City in 1923-4 and a director of the City transport undertaking.

We share with all others who had encountered his kindly personality a deep sense of loss, and our sympathy is with those who were nearest and dearest to him. We, in this office, have many memories of his kindness to us during our visits to Gloucester.

Inquiries and Answers

(In Which is Included General Correspondence)

Export/Near East

London, E.C.3.

The Editor, *Plastics*.

Dear Sir,—We have an inquiry from our friends abroad for electric light shades and electric wall brackets out of plastic material, as per samples sent to us.

These samples have the following factory mark: NB enclosed in a circle.

We would appreciate it very much if you would kindly let us know the name and address of the manufacturer of these special articles.

The same customers have sent us a sample of an egg slicer, also of plastic material, of which they want to buy a large quantity. This sample has the trade mark *Hygene*, Reg. Design No. 824253, Prov. Pat. No. 33432, and we hope you will also be able to give us the name of this factory.

BRUCE STARKE ENGEL AGENCIES, LTD.

[EDITOR'S NOTE.—The "NB" trade mark is the property of N.B. Mouldings, Ltd., of Tremlett Grove Works, Highgate, London, N.19, which makes the electrical equipment in question.

As for the trade mark "Hygene," we do not know the owners, but believe the egg slicer is moulded by Insulators, Ltd., of Leopold Road, Angel Road, Edmonton, London, N.18, and/or Moulded Products, Ltd., of Chester Road, Tyburn, Birmingham.]

Perfumed Cellulose Acetate

42-43, St. Paul's Churchyard,
London, E.C.4.

The Editor, *Plastics*.

Dear Sir,—In your January issue you mentioned an inquiry received from a manufacturer regarding the possibility of producing cellulose acetate artificial flowers with a perfume.

There is no difficulty in the manufacture of perfumed cellulose acetate sheet, although the variety of perfumes that can be used is limited to only two or three.

We have produced perfumed Rhodoid for the manufacture of combs and have pleasure in enclosing a sample of this material. We understand that perfumed cellulose acetate has been used in the United States for the manufacture of artificial flowers, and if there were a demand in this country for such a material we would have no difficulty in supplying it.

MAY AND BAKER, LTD.,
G. C. BELL.

Ice Cream Spoons

London, E.C.1.

The Editor, *Plastics*.

Dear Sir,—Your name has been given to us by The Commercial Ignition Company Limited as likely manufacturers of ice cream spoons in cellulose acetate.

We have pleasure in sending you herewith a set of these spoons, from which we would prefer if you would quote immediately for numbers 26/2 and 26/3.

We have imported these spoons in large quantities for many years from abroad, but as we cannot get an Import Licence at present, we think it would be a good opportunity for you to do a substantial business with us.

AMEX COMPANY.

[EDITOR'S NOTE.—We are not manufacturers of any plastic, but exist expressly to put users of plastics in touch with manufacturers.

The spoons in question are the well-known simple flat objects made of wood. They could, of course, easily be turned out in cellulose acetate and very rapidly, too, by the injection process. We should imagine, however, that the price would be several times that of the wooden spoon.

Roughly speaking, and making the same weight spoon, the cost would be of the order of 2s. per gross for the raw material alone. The cost of mould, working costs and strange items, such as profit, must be added.

Alternatively, the spoon could be stamped from the sheet, but even reckoning with no wastage owing to special design, the cost of the raw material would be about twice that for the moulded product for the same weight of spoon. However, special examination as to minimum thickness and size might result in a reasonable price. For real final costs, therefore, the reader should apply to manufacturers. A list of these is given in our Directory on page ii.

The unattractive part of this idea to the plastics industry is that the acetate spoon would have little chance of survival in peace-time. And, of course, it is such a waste of good material: the spoon is thrown away after being used only once.]

Window Panels

Wilmslow.

The Editor, *Plastics*.

Dear Sir,—Can you advise me on the following? I wish to equip two private houses with double windows, utilizing the existing wooden frames containing outside glass panes in metal frames. If there is a suitable transparent self-supporting plastic available at a reasonable price, I would be glad to know of it. I want to screw panels of the plastic direct to the wooden window frames. The panels would be easy to remove in the spring, would not be likely to get broken and would need no framework to support them, as glass would.

"Cellophane" would apparently be cheap, even on simple wooden frames which could be screwed to the main window frames, but the "Cellophane" contracts by degrees and tears away. It is also likely to be accidentally damaged. Cellulose acetate is the right sort of stuff, but far too expensive.

Reckoning, totally, 100 separate panels 4 ft. by 1 ft. 6 ins., is it possible to get the material that will do the job for £5, or even £10?

JOHN A. FIELDEN.

[EDITOR'S NOTE —We cannot advise any material other than cellulose acetate sheet. If 10-1,000 thickness sheet were used the cost would be little more than the upper limit given. Waste in cutting to size from a 55-in. by 24-in. sheet would mean higher costs, unless such waste pieces could be sealed together to form panels. 10/1000 thick sheet would, we believe, be sufficiently strong for the purpose, although the points at which it is nailed would be under strain. The use of an adhesive would have its advantages.]

Moulded Coffins

Boston, U.S.A.

The Editor, *Plastics*.

Dear Sir,—I have been referred to you by *Modern Plastics* of New York in my search for a copy of an article on coffins moulded from plastics. I understand that this has been done in England. If you have any available information on this subject please let me know. J. R. ELLIOTT.

[EDITOR'S NOTE.—This subject was discussed on p. 169 of our June, 1939, issue. Moulded coffins are manufactured by the Ultralite Casket Co., of Stalybridge. The moulding entails the use of about 90 lb. of moulding powder and is perhaps the largest to date.]

Book Covers

London, N.W.10.

The Editor, *Plastics*.

Dear Sir,—We have been interested, of late, in the use of plastics for book covers. The material should be of a durable, non-chipping nature and, say, about 1-12 to 1-16-in. in thickness. Various colours—quite a small range would be sufficient.

We shall be very glad if you can recommend to us any firms which specialize in a quality suitable to our use. The cost would, of course, have to be of a reasonable nature.

G. BLUNT AND SONS, LTD.

[EDITOR'S NOTE.—We fear that the whole problem of book covers, although extremely interesting, is almost hopeless because of cost. Cloth and, indeed, leather on cardboard and similar bases is so cheap that, normally, competition by plastics is out of the question. Books receive so much "knocking about" that we cannot conceive anything short of a resin impregnated canvas sheet for the job. What would be perhaps most suitable is a paper, cardboard or fabric impregnated with a solution or emulsion of a "vinyl" resin. This would probably give a very tough sheet capable of withstanding impacts.

For special jobs plastics are more promising. For example, readers may remember that in our July, 1937, issue we described the use of laminated sheet by Kalamazoo (Sales), Ltd., for making their ledgers. This sheet is combined with a rubber edging and has proved very successful. Readers will also remember the beautiful Bible cover of urea resin made by British Artid Plastics, Ltd. This is an instance where the book would be carefully treated and there is little danger of breakage.]

Office Fittings

Birmingham, 1.

The Editor, *Plastics*.

Dear Sir,—We are anxious to get in touch with manufacturers of Bakelite fittings for office use, or what are known as stationers' sundries; for instance—inkstands, book-ends, paperweights, etc., and other novelties.

One of our mutual friends, Messrs. Bakelite, Ltd., has suggested to us that probably the best source of information would be yourselves, and if you can give us the names of any manufacturers we should be extremely grateful.

RABONE, PETERSEN AND CO., LTD.

[EDITOR'S NOTE.—You should be able to get all you require from any of the following moulding concerns:—W. E. Amies and Co., Ltd., Ashdowns, Ltd., BX Plastics, Ltd., Crystalate, Ltd., Thos. De La Rue and Co., Ltd., Ebonestos Industries, Ltd., Injection Moulders, Ltd., Insulators, Ltd., Kent Mouldings, Moulded Products, Ltd., N.B. Mouldings, Ltd., Prestware, Ltd., United Ebonite and Lorival, Ltd. The addresses of these firms are given in our Directory on pages ii and iv.

Some of these office fittings can be made in cast resin, and applications should be made to the manufacturers, such as Catalin, Ltd., Erinoid, Ltd., etc., who could indicate the concerns that could provide the finished articles.]

Plastic Rods

Johannesburg.

The Editor, *Plastics*.

Dear Sir,—Some months ago you printed an account of a plastic material composed of synthetic resin and either sawdust or wood pulp, which had been produced by an American firm.

Price is, naturally, a very large factor and if this compound can be produced in rod form, at a price of approximately 6d., or less, per 12-ft. rod, the manufacturer can be assured of a monthly demand of at least 20,000 rods of various lengths.

I give hereunder a rough specification of the qualities desired and would ask you either to print this letter with the request that any firms interested communicate with me, or give me the names of those firms which, in your opinion, would be in a position to quote.

The rods required will be in lengths ranging from 6 ft. to 12 ft., with diameters ranging from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in., and must have the same impact strength as any hard wood.

They must be non-inflammable, must not throw a spark when rubbed against rock, must have a low water absorption and a high resistance to abrasion.

F.H.C.

[EDITOR'S NOTE.—The reader is ingenious. We can assure him that it does not require great intelligence to realize that there would be much greater demand than 20,000 rods per month if the price were 6d. for 12-ft. rods. We are not being horribly sarcastic, but let him make a simple calculation with us. A 12-ft. by 1-in. cylindrical rod has a volume of about 112 cubic ins. With a specific gravity 1.4 it would weigh about $5\frac{1}{2}$-6 lb., so that he requires a finished material at about 1d. per lb. This is manifestly ridiculous. Modern moulding powders cost about 10 times this, to which must be added cost of extrusion. The reader must avoid falling into the trap so many without a knowledge of plastics do—since sawdust (as he calls it) can be had for next to nothing, therefore anything made from it must cost next to nothing. He must remember that a good moulding powder contains 50 per cent. synthetic resin.

He must wait for the time when sawdust can be moulded with about 1 per cent. of resin only. That time is very far off and would produce a very poor material. He requires a high-grade rod with properties far superior to wood and yet does not wish to pay the price. If he can make high-grade boots at 1s. a pair we know a market of about 500,000,000 per annum.]

Buttons

Birmingham.

The Editor, *Plastics*.

Dear Sir,—Enclosed please find two buttons made from a plastic material. Could you give us the name and address of the manufacturer of this material?

J. RICHARDSON.

[EDITOR'S NOTE.—The buttons appear to be made of casein, and may be of Erinoid, Lactoid or any other casein plastic on the market. The reader should communicate with Erinoid, Ltd., BX Plastics, Ltd., or the other manufacturers named in our Directory.]

TRADE AND PERSONAL NOTES

N. V. Hercules Powder Company, The Hague, Holland, has forwarded us its latest publication, entitled "Hercules Chemist," which contains a good deal of information of interest to the plastics industry. There is a particularly useful article arranged in the form of a question and answer discussion of the value of chlorinated rubber in modern industry.

Henry Butcher and Co., 63-64, Chancery Lane, London, W.C.2, has sent us particulars of its sales by auction of industrial property, plant and machinery.

Drayton Regulator and Instrument Co., Ltd., has just issued a new folder (PP.48) dealing with its well-known Drayton automatic electric switches and valves. The publication is well illustrated and contains information of considerable interest to works engineers.

Short and Mason, Ltd., has issued a new catalogue describing its industrial instruments. It occupies nearly 50 pages, is fully illustrated and spiral bound. The instruments include, for example, recording and other controllers for temperature, humidity, etc., valves, compressors, thermometers, pressure gauges and various accessories.

Evershed and Vignoles, Ltd., Chiswick, London, W.4, has sent us its publication, No. M.200, which describes the applications of the well-known Megger instruments in modern industry.

Crofts (Engineers), Ltd., Thornbury, Bradford, has sent us its catalogue S.140, which lists its range of standard power transmission appliances.

Greenwood and Batley, Ltd., Albion Works, Leeds, reminds us that, with coal costs steadily rising, the importance of a properly designed valve is now being realized. A wisp of steam constantly escaping from a badly seated valve can seriously increase coal costs. Full particulars of the Greenbat valve can be obtained on application to the head office of the company.

Paper Sacks, Ltd., and Sack Fillers, Ltd., Marshalsea House, Long Lane, Borough, London, S.E.1, have forwarded us particulars regarding their Filasac System. This consists of preclosed (valved) paper sacks and the machines for filling them. The sewing of filled sacks or its alternative of bunching and tying is completely eliminated, thereby saving the cost of both labour and closing materials. The machines are dustless, speedy, labour-saving, and the paper sacks are dust-proof, moisture-proof and odour-proof.

British Electrical Development Association and the E.L.M.A. Lighting Service Bureau have forwarded us a copy of "Modern Factory Lighting," which includes special war-time requirements. The book, which sells at 8s. 6d., is likely to prove of considerable value to works managers in all industries, and not least to the executives in both moulding and plastic material manufacturing plants. There is an interesting section dealing with the inspection of transparent materials, in which it is stated that the method usually employed is to illuminate an opal glass panel from behind, viewing the transparent article against the lighted panel, which may be either vertical or horizontal, depending on convenience. In the tables of recommendations for suitable illumination in industrial interiors the plastics industry is unfortunately omitted, but the average foot-candles recommended for the rubber industry is eight, the range being from 6-10.

Anglo-French Trade Talks are being encouraged by the British and French Governments, and arrangements have been made for a meeting between British and French industrialists for the purpose of discussing economic and commercial questions of common interest. The Federation of British Industries has invited the Confédération Générale du Patronat Français to send a small delegation to London, and this invitation has been accepted.

It will be the object of the meeting to discuss the views of the industries of both countries on the following points:—

The means by which British and French industry can best co-operate during the war for the attainment of the common objective and for the solution of any difficulties which may confront them.

Means of collaboration by which after the war the industries of the two countries could jointly contribute to an orderly change-over from war to peace conditions and to the creation of a more sound and stable world economic system.

If, as is confidently expected, it is found that there is agreement on points of principle, it will be the object of the meeting to encourage conversations between individual industries in the two countries, in order that practical effect may be given to the principles upon which agreement has been reached.

The Federation of British Industries welcomes this opportunity of showing its friendship towards French industry and of contributing towards a strengthening in the industrial field of the ties which unite the two countries.

Import of goods for use in scientific research is now possible, as the Treasury now gives notice that it will consider applications for licences to import, free of duty, goods intended to be used in scientific research. Such applications, which should be addressed to the Secretary, H.M. Treasury, Whitehall, London, S.W.1, must be made on behalf of educational institutions, hospitals or recognized scientific laboratories (including laboratories maintained by industrial organizations or consultants) and must be accompanied by a written statement by the responsible professor or director. This statement should indicate the scientific purpose for which the goods are required and justify the claim that a suitable alternative is not obtainable in the United Kingdom.

Obituary

Professor Sir Gilbert Morgan, F.R.S., died on February 1, and his death will be greatly regretted by all his many friends and admirers in the chemical and allied industries. Professor Morgan's name will always be associated with the building up of the Chemical Research Laboratories at Teddington, of which he was made director in 1925, when they were first set up. Previously he had had a distinguished career, being assistant professor in chemistry at the Royal College of Science; professor in the faculty of applied science, Royal College of Science for Ireland; professor of applied chemistry at the Technical College, Finsbury, and mason professor of chemistry at Birmingham, whence he passed to Teddington. It will be remembered that Professor Morgan carried out a great deal of valuable research in connection with new resins, particularly new tannin bodies with base exchange properties.

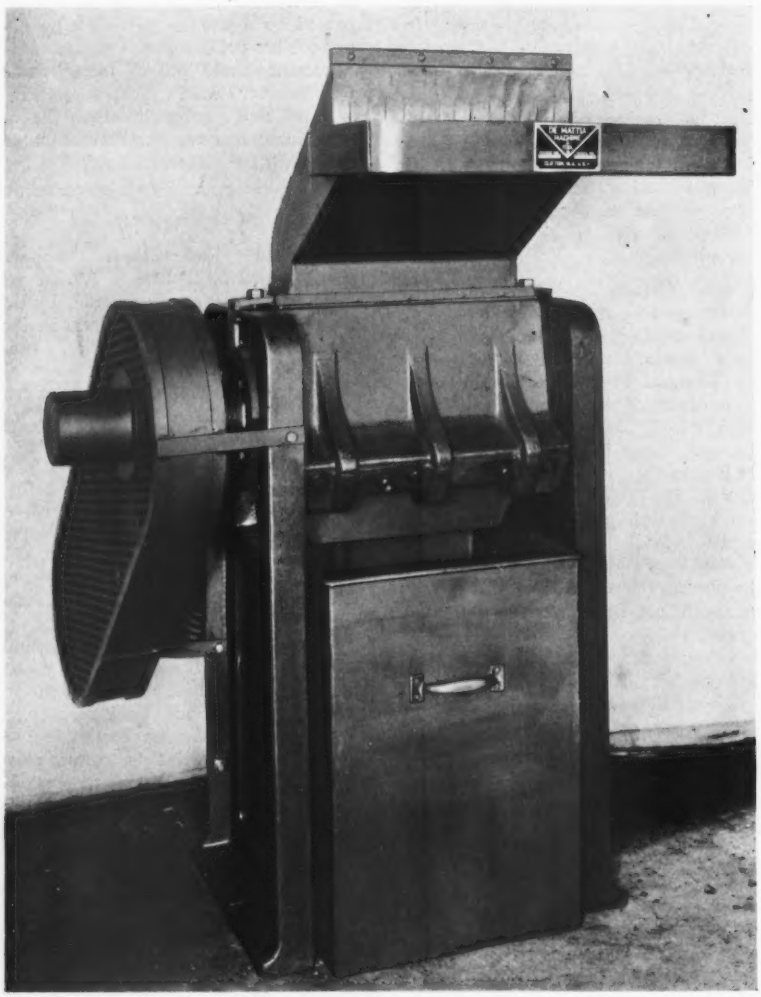
Mr. W. A. S. Calder, F.I.C., M.I.Chem.E., passed away on January 6. He was president of the Institute of Chemistry and a member of the Delegate Board of the General Chemical Group of I.C.I. and chairman of the Control Committee of the Midland and South Wales Division of that Group.

Sir Francis Goodenough, C.B.E., whose death we regret to announce, was well known as controller of gas sales of the Gas Light and Coke Co. For many years he was executive chairman of the British Commercial Gas Association.

NEW MATERIALS—NEW PLANT

De Mattia Acetate Grinder

This sturdy machine for grinding plastic materials has been specially designed to meet the needs of the plastics industry. The centre casting, or "Stator," can be removed in one piece for quick and thorough cleaning. The grinder has a capacity of 200 lb. per hour and is driven by means of a 3 h.p. motor with double "V" belt and cast-iron pulleys. Self-aligning hour-glass bearings with positive seal are important and much-appreciated features of the machine. The actual grinding mechanism consists of four steel chopper blades with inserted tool steel cutting edges and the standard screen is provided with ¼-in. openings. The net weight of the machine with motor is approximately 600 lb. Messrs. Dowding and Doll, Ltd., Greycoat Street, Westminster, London, S.W.1 (temporary war-time premises at 3, The Green, Wimbledon Common, London, S.W.19), are the British agents and all inquiries regarding the grinder should be addressed to them.



Indicating Temperature Controller

We have just been notified by George Kent, Ltd., the manufacturers of the well-known Multelec potentiometer range, of an interesting extension. It is intended for use with heat-treatment plant where a temperature record may not be required. It is available in two forms: the two-position, or "on and off" and the three-position control. In the two-position form of control the valve or contactor is either in the fully-on or fully-off position. When used on fuel-fired furnaces the motorized valve should be provided with an adjustable by-pass so as to reduce the inevitable hunt to the smallest dimensions possible. Two-position control is suitable for the majority of heat-treatment furnaces, and particularly for those of the batch type having constant loading conditions.

In three-position control, additional contacts are provided on the instrument and on the motorized valve. Normally, the control operates between the intermediate switches. If, however, changes in loading cause a large rise or fall in temperature the corresponding outer contact is made and the valve is moved to a greater extent in the closing or opening direction. This form of control is particularly suited to furnaces requiring a rapid heat up followed by a soaking period.

The mechanism of the instrument is enclosed in a cast aluminium casing which is designed for wall or flush panel mounting, and the whole of the mechanism is hinged so that it can be swung round clear of the casing without interruption of its functioning.

The instrument is of the potentiometric type, the e.m.f. to be recorded being balanced against the voltage drop along the potentiometric wire carrying the current. The slide wire is wound on the periphery of a disc and is of ample length, a cold junction compensation coil is provided, and current is supplied to the complete circuit through a rheostat from two ordinary dry batteries.

One end of the thermocouple is connected to a roller making contact with the slide wire and the other to a robust but sensitive moving coil galvanometer. To obtain the balance the slide-wire disc is rotated automatically until the galvanometer is not deflected, the position of the disc, which is also the position of the indicating pointer and the control disc, then representing the e.m.f. of the thermocouple and therefore the temperature.

The instrument automatically standardizes its own current voltage every 54 minutes, and this provides an ideal check on the reliability of the potentiometer. Current standardizing can also be effected manually at any time.

The control setting point can be adjusted by means of a knob which is situated on the front of the instrument casing. Rotation of this knob moves the control contacts bodily round the slide-wire spindle, causing them to take up a different position relative to the cams on the periphery of the controls.